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THE APPLICATION OF VALID AND FEASIBLE DIETARY ASSESSMENT  
METHODS TO EVALUATE THE IMPACT OF POLICY AND  
BEHAVIORAL INTERVENTIONS ON CHILDREN'S  
FRUIT AND VEGETABLE CONSUMPTION

A Dissertation Presented

by

Sarah Anne Amin

to

The Faculty of the Graduate College

of

The University of Vermont

In Partial Fulfillment of the Requirements  
For the Degree of Doctor of Philosophy  
Specializing in Animal, Nutrition and Food Sciences

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## ABSTRACT

The majority of U.S. children do not meet recommendations for fruit and vegetable (FV) consumption. FV confer numerous health benefits including intake of critical shortfall nutrients, reduced risk of chronic diseases, and maintenance of healthy weights. Identifying both policy and behavioral approaches to increase children's consumption of a variety of FVs has become a public health priority. When evaluating policy and interventions it is integral to apply validated dietary assessment methods to measure FV selection, consumption, and waste. The three aims of this dissertation addressed the feasibility of dietary assessment methods and their application to evaluate policy change and behavioral interventions.

*Aim 1:* Apply validated dietary assessment methods to evaluate the effect of national school lunch policy change on elementary school children's FV consumption. As of the 2012 school year, the United States Department of Agriculture (USDA) requires school children to select either a fruit or a vegetable with a reimbursable meal. The objective of the first study was to compare children's FV choices in two school cafeteria environments a year before these new USDA regulations took effect. Elementary school (grades 3-5) children's FV choices were measured during Spring 2011 at two northeast elementary schools (NES-A and NES-B). NES-A had a self-serve salad bar, whereas NES-B served pre-portioned FV and pizza daily. Of 555 trays assessed ( $n=284$  NES-A,  $n=271$  NES-B), 15.3% ( $n=85$ ) had no FV selected. A higher percentage of trays from NES-A had no FV (23.6%,  $n=67$ ) in comparison to NES-B (6.6%,  $n=18$ ) ( $P<0.0001$ ). On average children selected more processed FV (PFV) (80.8g) than whole FV (WFV) (40.5g,  $P<0.001$ ). The mean amount of FV selected was lower in NES-A (111.4g) than NES-B (131.5g,  $P<0.01$ ). When trays without a FV were removed, quantities selected were not significantly different between schools ( $P=0.46$ ). For PFV, 100% fruit juice was on 41.4% of trays ( $n=230$ ) and pizza was on 42.1% of NES-B trays ( $n=114$ ). Trays with pizza or 100% fruit juice were less likely to have a WFV ( $P<0.001$ ,  $P<0.0001$  respectively). In the second study, elementary school children's FV selection, consumption and waste were compared in two northeast elementary schools before the USDA rule in spring 2012 (10 school visits, tray observations  $n=498$ ) and following the USDA rule in spring 2013 (11 school visits, tray observations  $n=944$ ). More children selected FVs in higher amounts when FVs were required compared to when they were optional (0.69 cups vs. 0.89 cups,  $P<0.001$ ); however, consumption decreased slightly (0.51 cups vs. 0.45 cups,  $P=0.01$ ) and waste increased (0.25 cups vs. 0.39 cups,  $P<0.001$ ).

*Aim 2:* Address the feasibility of non-research volunteers (teachers and parents) collecting digital imaging (DI) dietary assessment data in a sample of elementary schools. Two Northeast Elementary Schools (NES-A and NES-B) were recruited and a parent-based dietary assessment team (PDAT,  $n=5$ ) and teacher based dietary assessment team (TDAT,  $n=4$ ) were formed. We compared data collected by the PDAT and TDAT with the university-based dietary assessment team (UDAT). Feasibility was measured based on the total number of DI pairs collected out of the total number of eligible DI pairs across all data collection days for each of the three teams. Using binary logistic regression, at NES-A, the PDAT was less proficient at collecting DI pairs (74.1%,  $n=218$  of 294 LD) than the UDAT (81.9%,  $n=262$  of 320 LD,  $P<0.05$ ). At NES-B, the TDAT was better able to capture DI pairs (95.9%,  $n=257$  of 268 LD) than the UDAT (91.3%,  $n=366$  of 401 LD,  $P<0.05$ ).

*Aim 3:* Apply weighed plate waste (WPW) as a validated dietary assessment method to evaluate a behavioral intervention addressing pre-school aged children's FV consumption during afternoon snack time using older elementary school children as "FV Mentors". Two Northeast pre-school classrooms (NEPC-A and NEPC-B) at the Burlington, VT YMCA were recruited for the study. Children in grades 3-5 who participated in the Live Y'ers Afterschool program were recruited to model FV consumption and use FV verbal cues during the intervention period in addition to teacher FV verbal cues. In NEPC-A ( $n=15$ ) based on a repeated measures ANOVA with mixed design analysis, there was a significant main effect of time on FV consumption as measured by the mean amount of cups of FVs consumed [ $F(2,10)=7.89$ ,  $P=0.009$ ] across study periods. Mean consumption was lowest at baseline at 0.16 cups (95% CI: 0.10-0.22) and increased during both the intervention period ( $M=0.26$  cups, 95% CI: 0.17-0.36) and the follow-up period ( $M=0.33$  cups, 95% CI: 0.28-0.38). The main effect of time (study period) was qualified by a significant interaction between time and type of FVs consumed [ $F(8,10)=3.10$ ,  $P=0.049$ ] indicating that the effect of study period on FV consumption depended on the type of FVs consumed. In NEPC-B ( $n=16$ ) there was not a significant main effect of time on FV consumption [ $F(2,10)=1.10$ ,  $P=0.372$ ].

## CITATIONS

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## **CHAPTER 1: COMPREHENSIVE LITERATURE REVIEW**

### **Childhood Obesity**

#### **Prevalence and Health Risks of Childhood Obesity**

The prevalence of childhood obesity in the United States has undeniably become one of the most critical public health issues facing our nation with approximately 12.7 million children between the ages of 2 and 19 obese (Ogden, Carroll, Kit, & Flegal, 2014). Children between the ages of 2-5 years of age have seen the most improvement in recent years with a decrease of 5% between 2011-2012 (Ogden et al., 2014). In addition, parts of the US including Philadelphia, New York City, Mississippi, and California have seen slightly decreased rates of childhood obesity (Robert Wood Johnson Foundation, 2012). By implementing comprehensive plans that address the retail and school food environments, these cities and states have demonstrated that steadfast efforts are integral to reducing this epidemic (Robert Wood Johnson Foundation, 2012).

Obese children are at a higher risk for type II diabetes, a disease that previously was considered an adult disease (Biro & Wien, 2010; Han, Lawlor, & Kimm, 2010; Whitlock, Williams, Gold, Smith, & Shipman, 2005) as well as high blood pressure, high cholesterol (Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007; Han et al., 2010), fatty liver disease (Han et al., 2010), and psychosocial complications (Han et al., 2010). Other health problems associated with child obesity include breathing issues including sleep apnea, asthma (Han et al., 2010; Sutherland, 2008), and joint problems (Han et al., 2010). Current dietary patterns in US children represent an important target for change.

## **Current Dietary Patterns**

Children's diets are influenced as early as infancy (Birch, Savage, & Ventura, 2007) with the first five years marked by the development of important dietary behaviors (Birch, 1979; Birch & Marlin, 1982; Birch, McPhee, Steinberg, & Sullivan, 1989; Savage, Fisher, & Birch, 2007). Identifying strategies to encourage children's fruit and vegetable (FV) preferences and consumption is essential since it can set the stage for eating patterns throughout youth and adulthood (Savage et al., 2007). American children's diets are marked by intake of high calorie foods and often lack the appropriate nutrients for growth and development (Keast, Fulgoni, Nicklas, & O'Neil, 2013). Similar to adults, the excessive intake of calories is an underlying factor of the obesity epidemic in youth (Wang, Orleans, & Gortmaker, 2012). Consumption of foods from the milk and milk products, grain, fruit, and vegetable groups have been associated with decreased levels of obesity in adolescents (Bradlee, Singer, Qureshi, & Moore, 2010). It is important to include these food groups in children's diets, while at the same time being aware of how they are prepared.

At a young age, children (2-6 years old) are consuming more foods high in added sugars, solid fats, and sodium including pizza/calzones, Mexican dishes, savory snacks, candy, and fruit juice (Ford, Slining, & Popkin, 2013). This trend continues throughout childhood with grain-based desserts being the top sources of calories for children 6-11 years old (Drewnowski & Rehm, 2013). Popular food items in the diets of teens (12-19 years old) include soda, energy and sports drinks, and pizza (Drewnowski & Rehm, 2013). An important factor contributing to the consumption of "empty calories" (calories from solid fats such as butter and added sugars such as soft drinks) among children is the

increase in snacking (27% of daily calories), predominantly in the form of salty snacks and candy (Piernas & Popkin, 2010).

### **Importance of FV Consumption**

FV consumption has become a central focus of efforts to cultivate healthy dietary behaviors in children because they are low in calories and rich in essential nutrients. Fruits and vegetables confer an array of health benefits including intake of critical shortfall nutrients, reduced risk of chronic diseases, and weight maintenance (U.S. Department of Agriculture, 2010). Children are not meeting recommendations for FV consumption (National Center for Chronic Disease and Prevention and Health Promotion, 2014). Recent reports suggest that while whole fruit consumption has increased by 63% (displacing 100% fruit juice) between 2007-2010, 9 out of 10 children still did not eat enough vegetables and the majority of vegetables consumed were white potatoes (National Center for Chronic Disease and Prevention and Health Promotion, 2014). Identifying strategies to increase young children's consumption of a variety of fruits and vegetables has become a public health priority.

### **Child Nutrition Environment**

Recent efforts to improve Americans' diets have shifted from a focus on the individual to the broad food environment (Fielding, 2011; Karpyn, Young, & Weiss, 2012). There are numerous aspects of the food environment that may impact diet including access and availability such as proximity to grocery stores, supermarkets (Franco et al., 2009; Larson, Story, & Nelson, 2009; Michimi & Wimberly, 2010; Saelens et al., 2012), and fast food restaurants (Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011; Forsyth, Wall, Larson, Story, & Neumark-Sztainer, 2012; Hilmers,

Hilmers, & Dave, 2012), food prices (Beydoun, Powell, Chen, & Wang, 2011), food advertising (Chandon & Wansink, 2012; Harris, Bargh, & Brownell, 2009), and food portion sizes (Lediwke, Ello-Martin, & Rolls, 2005; Levitsky & Youn, 2004; Piernas & Popkin, 2011). There are also aspects of the interpersonal environment such as family meals (Fruh, Fulkerson, Mulekar, Kendrick, & Clanton, 2011; Fulkerson, Story, Neumark-Sztainer, & Rydell, 2008) and meals eaten away from home (Fulkerson et al., 2011; Larson, Neumark-Sztainer, Laska, & Story, 2011) that can impact dietary patterns.

### **Food Marketing**

Food marketing is widespread in the US and can impact the obesity epidemic by influencing people's food purchasing behavior and consumption (Chandon & Wansink, 2012). Limiting food marketing to children has become a public health priority in terms of the nutritional quality of foods promoted (Powell, Schermbeck, Szczypka, Chaloupka, & Braunschweig, 2011) and their corresponding impact on diet-related health (Andreyeva, Kelly, & Harris, 2011; Cairns, Angus, Hastings, & Caraher, 2013). Though there have been marginal improvements to television advertisements (Harris, Sarda, Schwartz, & Brownell, 2013), one study found that 86% of ads seen by children promoted foods high in saturated fat, added sugars, and sodium (Powell et al., 2011). The majority of foods advertised to children on websites are marked as "foods to avoid" by the Institute of Medicine (IOM) standards (Lingas, Dorfman, & Bukofzer, 2009). The food industry prioritizes marketing to younger populations by spending 63% of marketing on carbonated beverages, fast food, and breakfast cereals and often using animated or fictional characters that appeal to children (Cairns et al., 2013). Evidence supports that food advertising is associated with consumption of energy dense and

nutrient poor foods, particularly fast food and soft drinks (Andreyeva et al., 2011; Cairns et al., 2013).

Marketing to children is an important area of focus when considering factors that contribute to childhood obesity. Various companies have responded by participating in the Children's Food and Beverage Advertising Initiative (CFBAI), which aims to market healthier foods to children (Harris & Graff, 2011). However, a recent evaluation of CFBAI questioned its effectiveness due to program restrictions and highlighted the minimal impact that it has had on current marketing practices (Harris et al., 2013). Expert recommendations point to the role that policies could play in marketing to children (Nestle (2006). For example, the use of cartoon characters and celebrity endorsements in food advertising to children could be limited (Nestle, 2006). Though research is limited, one county in California has implemented a toy ordinance that restricts the inclusion of a toy in a restaurant meal that includes foods of low nutrient density (Otten et al., 2012). An evaluation of this regulation found improvement in the marketing of healthy food items (Otten et al., 2012).

### **Home Environment and Family Meals**

The home environment has been recognized for its role in shaping the dietary behaviors of children through family mealtimes (Cooke et al., 2004) and parental influence (Cooke et al., 2004; Cullen et al., 2001; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Natale et al., 2014; Nicklas et al., 2001; O'Connor et al., 2010; Ohly et al., 2013; Wardle et al., 2003; Young, Fors, & Hayes, 2004). The daily ritual of family meals—defined by homemade foods and family members putting aside their work, school, and social commitments to gather around the table—has experienced a sharp

decline since the 1960s (Cinotto, 2006). An assessment of time use shows that between 1965-1966 and 2007-2008 time spent cooking decreased substantially (Smith, Ng, & Popkin, 2013). Women spent over 45 minutes less time cooking per day over this time period, and low-income groups demonstrated the steepest decline (Smith et al., 2013). The increased number of mothers in the work place along with work-life stress contributes to this trend (Bauer, Hearst, Escoto, Berge, & Neumark-Sztainer, 2012; Neumark-Sztainer et al., 2011). For example, full-time employed mothers are less likely to have adequate time to prepare food (Bauer et al., 2012; Fulkerson et al., 2011) and family meals than non-employed mothers (Bauer et al., 2012). Often, these people resort to quick and easy options, such as fast food (Larson, Nelson, Neumark-Sztainer, Story, & Hannan, 2009). Though the impact of family meals on body mass index (BMI) is unclear (Berge et al., 2012; Sobal & Hanson, 2011), its impact on positive dietary patterns is significant (Berge et al., 2012; Burgess-Champoux, Larson, Neumark-Sztainer, Hannan, & Story, 2009).

Regular family meals during the teen years are a good predictor of future dietary behaviors later in life (Burgess-Champoux et al., 2009). However, outside of family meals, the home environment can also serve as a source of low-nutrient, high-calorie foods such as baked goods, candy, dairy-based desserts, and sugar-sweetened beverages for youth (Briefel, Wilson, & Gleason, 2009). It is important to evaluate how the home environment contributes to food and meal offerings available to children. In adults, consistent family meals are associated with increased consumption of fruits and vegetables (Berge et al., 2012; Larson et al., 2009) and more desirable eating patterns, such as decreased fast food consumption (Berge et al., 2012).



The beneficial effects of parental modeling and exposure to FVs on children's FV consumption has been well documented (Cooke et al., 2004; Cullen et al., 2001; Fisher et al., 2002; Natale et al., 2014; T. Nicklas et al., 2001; O'Connor et al., 2010; Ohly et al., 2013; Wardle et al., 2003; Young et al., 2004), whereas pressuring a child to eat their food can have a negative impact (Galloway, Fiorito, Francis, & Birch, 2006). Beyond the mealtime setting, parenting style can affect a child's weight status with children more likely to be obese in an authoritarian household compared to authoritative household (Kakinami, Barnett, Seguin, & Paradis, 2015). In order to improve children's diets, interventions must focus on meals, beverages, and snacks served both inside and outside the home. One way to address eating behaviors is through the pre-school and school environment since children may receive one-half to two-thirds of their nutritional needs in these settings (U.S. Department of Health and Human Services, 2015).

### **School Nutrition Environment**

The school nutrition landscape has been subject to promising changes as evidenced by improvements to the U.S. Department of Agriculture (USDA) National School Lunch Program (NSLP) and School Breakfast Program (SBP) and the growth of Farm to School Programs. School cafeteria meals are a promising setting for promoting knowledge and skills surrounding foods and school meals can be developed as a learning tool to connect teachers and students (Benn & Carlsson, 2014). Addressing the school cafeteria food environment teacher (Slawson et al., 2013) community, and family involvement (Kehm, Davey, & Nanney, 2015), are integral to the adoption of both healthy nutrition and physical activity practices in schools (Kehm et al., 2015; Slawson et al., 2013).

Beyond the cafeteria, Farm to School has gained national recognition for its potential to positively influence and correlate children's FV consumption behaviors such as attitudes, knowledge, and exposure through strategies such as gardening, cooking, or taste-testing (National Farm to School Network, 2013; Yoder et al., 2014). According to the 2013 USDA Farm to School Census, 44% of school districts surveyed in 2011-2012 reported engaging in Farm to School programming and 31% reported growing edible gardens (U.S. Department of Agriculture, 2013b). Exposure to Farm to School programming was associated with increased FV consumption among participants who initially had the lowest FV intake (Yoder et al., 2014).

### **The National School Lunch Program**

Increasing children's consumption of FV is an important goal of the National School Lunch Program, which feeds 30 million children each school day (U.S. Department of Agriculture, 2014). NSLP participants consume higher amounts of fruits or 100% fruit juice as well as vegetables (though predominantly potatoes) compared to non-program participants (Story, Nannery, & Schwartz, 2009). In Fall 2012, the NSLP implemented new regulations. Revisions included calorie maximums and changes to the "Offer Versus Serve" (OVS) rule. In the past, students were permitted to decline any two of the five meal components, including a fruit or vegetable (U.S. Department of Agriculture, 2013d). The USDA requires school children to select either a fruit or a vegetable with a reimbursable meal in an effort to increase FV consumption (U.S. Department of Agriculture, 2012b).

The implementation of this requirement was immediately met with concerns surrounding operational challenges, FV waste, and increased costs (Byker, Pinard,

Yaroach, & Serrano, 2013). During the initial implementation period, the new NSLP regulations were met with some resistance. The USDA/Food and Nutrition Service (USDA/FNS) sought feedback from school nutrition experts who reported operational challenges related to regulations for meat/meat alternates and grains (U.S. Department of Agriculture, 2012a). The USDA/FNS responded by repealing weekly maximums for grain and proteins while maintaining the calorie limits (U.S. Department of Agriculture, 2012a). There were additional concerns regarding how the guidelines may affect children's FV consumption and plate waste.

Two years later, school districts and states have reported increased waste by students (School Nutrition Association, 2014; U.S. Government Accountability Office, 2014). In a recent survey completed by school nutrition directors (n=240), over 80% subjectively reported an increase in the amount of FV (especially vegetables) wasted by students (School Nutrition Association, 2014). Increased FV waste (Byker, Farris, Marcenelle, Davis, & Serrano, 2014; Just & Price, 2013) and decreased consumption (Wengreen, Aguilar, Madden, & Jones, 2014) following the new USDA rule has been found by other studies of elementary school children's food consumption. However, there have been some promising findings regarding the impact of the new USDA rule on children's FV consumption, including an increased percentage of students who consumed at least one serving of FV in a sample of three schools (20% FV optional vs. 28% FV required,  $p<0.01$ ) (Just & Price, 2013).

The new USDA regulations not only require children to select a FV but also require schools to offer a greater variety of vegetables (U.S. Department of Agriculture, 2012b). Cohen and colleagues reported that though the percentage of trays with a

vegetable did not increase in 3<sup>rd</sup> through 8<sup>th</sup> grade elementary school children after the new rule, vegetable consumption increased (0.13 cup vs. 0.30 cup,  $p<0.0001$ ) (Cohen, Richardson, Parker, Catalano, & Rimm, 2014).

Children entering elementary school under the new USDA rule may respond better to the FV requirement. Under the new requirement younger children (grades 1-3) were found to consume more FV when required compared to older children (grades 4-5) (Wengreen et al., 2014). Adjustment to the new requirement may take time, especially since older children were accustomed to having the option whether or not to choose a FV. Changes to other school meal policies may reinforce positive behaviors in children, such as “Smart Snacks in Schools”. This policy sets maximums on the amount of calories, salt, sugars, and fat contained in school snacks and promotes FV as one of the main ingredients (U.S. Department of Agriculture, 2013c). Additionally, there is evidence to suggest that children attending schools in states with weak competitive state-specific food laws had increased odds (20%) of being overweight or obese compared to children in states with strong competitive food laws (Hennessy et al., 2014).

### **Pre-School Nutrition Environment**

Pre-schools represent an important environment for addressing children’s FV consumption (Addessi, Galloway, Visalberghi, & Birch, 2005; Nicklas et al., 2013) since an increased proportion of young children are consuming meals outside of the home (U.S. Department of Education, 2007). Approximately 55% of children (3-6 years) are in a child care (Federal Interagency Forum on Child and Family Statistics, 2013) which offers an opportunity to positively influence dietary behaviors in this setting.

## **Pre-School Nutrition Policies**

The Child and Adult Care Food Program (CACFP) oversees the nutrition needs of pre-school aged children (ages 3-5) in licensed childcare centers eligible for free or reduced price meals including the Head Start program with children that meet this program's low-income criteria (U.S. Department of Agriculture, 2013a). Head Start is a federally funded pre-school program aimed at promoting mental, social, and emotional development of low-income children (family income <100% of the federal poverty line) between 3-5 years (Lumeng et al., 2015; U.S. Department of Health and Human Services, 2015).

By working with CACFP, Head Start ensures that all center-based children's nutritional needs are met (U.S. Department of Health and Human Services, 2015). Additionally, it supports nutrition education and provides resources to children and parents including "Ten Steps to Fill Your Grocery Bag Through the Food Stamp Program" and the "Farmers' Market Nutrition Program" (U.S. Department of Health and Human Services, 2015). Childcare centers that participate in CACFP are responsible for providing at least one of the following meal types: breakfast, lunch, snack, or dinner (U.S. Department of Agriculture, 2013a). All meals must provide at least one-half cup of vegetable or fruits or a fruit or full-strength vegetable or fruit juice, or any combination of these foods with the exception of lunch which must provide two more of these items and snack for which a fruit or vegetable is optional (U.S. Department of Agriculture, 2013a).

The benefits of Head Start on children's weight status (Lumeng et al., 2015) and nutrition (Dev, McBride, Speirs, Donovan, & Cho, 2014; Ritchie et al., 2012) are

emerging. In fact, children with an unhealthy weight that participated in Head Start had a significantly improved BMI upon entering kindergarten compared to two age-matched samples derived from a primary health care system (Lumeng et al., 2015). The nutritional quality of food provisions at Head Start and CACFP centers may be one component that contributes to a healthier weight in these children. In one study, CACFP sites and Head Start centers served more FV and fewer sugar sweetened beverages and sweet snacks than non-CACFP sites (Ritchie et al., 2012). This is important to consider since few childcare centers meet nutrition practice guidelines set forth by the Academy of Nutrition and Dietetics and by Head Start (Dev et al., 2014). However, similar to elementary schools, Farm to School programs are increasing in the pre-school setting with 30% of school districts reported having Farm to School activities (U.S. Department of Agriculture, 2013b).

### **Evaluation of Dietary Assessments in Children**

The accurate and feasible measurement of children's food consumption is critical to evaluating the impact of regulatory changes to the NSLP, as well as behavioral interventions that address children's FV intake. For example, it is important to understand whether the 2012 NSLP guidelines *requiring* students to take a fruit or vegetable results in increased consumption or simply increased waste.

#### **Novel Self-Reported Dietary Assessment Methods**

##### *Automated self-administered 24-hour recall (ASA-24) and web-based FFQ*

The need for technological advances has been a priority for improving the efficiency, time, labor, and costs of dietary assessment methods. One of the first investments in the area of technology and dietary assessment began in 2004 when the

National Cancer Institute provided the financial support to develop an automated self-administered 24-hour dietary recall (ASA) (Thompson, Subar, Loria, Reedy, & Baranowski, 2010). Dietary assessment is a rapidly evolving discipline that has incorporated technological advances and cutting edge science to improve both self-report measures and objective measures of what children eat.

Since 2004, the ASA-24 has developed considerably to incorporate two websites: one for the researcher and one for the respondent (Subar et al., 2012). The respondent site has an engaging interface and uses a penguin to guide the user through the completion of a 24-hour recall with ample visual and audio cues (Subar et al., 2012). Now available to researchers, clinicians, and educators, this tool addresses the feasibility and cost of traditional dietary assessment methods (Subar et al., 2012). In children, the ASA-24 was not easily adopted for those between the ages 8 and 13 as evidenced by food omissions by this age group (Baranowski et al., 2012). Thus, an adaptation of the ASA-24 called the Food Intake Recording Software System 4 (FIRSST4) was developed to be simpler to use and tailored to foods often reported by children (Baranowski et al., 2014). In adolescents, a web-based FFQ has been shown to be valid for certain food groups including water, fruit, bread, fish, eggs/meat when validated against 3-day estimated food records (Matthys, Pynaert, De Keyzer, & De Henauw, 2007).

#### *Mobile telephone food records*

For other self-report measures of dietary assessment, technology is focused on reducing the burden placed on the subject (Daugherty et al., 2012). For example, in adolescents the mobile telephone food record is an application that takes advantage of widely used cell phone technology and its image capturing capabilities by having subjects

capture pre- and post-images of their meals (Daugherty et al., 2012). In terms of the feasibility, training factors and age-appropriate strategies may need to be developed (Daugherty et al., 2012). Nonetheless, this may be a promising alternative to more time and resource intensive self-report measures.

#### *Limitations of self-reported dietary assessment methods*

Recent articles published by Dhurandar et al. and Archer et al. highlight a commonly disputed topic in dietary assessment—how well do self-reported dietary assessment methodologies actually reflect dietary intake (Archer, Pavea, & Lavie, 2015; Dhurandhar et al., 2014). The authors posit that methods that are “cheap and convenient” do a disservice to healthcare advice and policies (Dhurandhar et al., 2014). The commonly cited limitations of these methods include reliance on human memory, false recall, and inaccurate measurement and incorporation of physical activity into diet-disease relationships (Archer et al., 2015). It was suggested that when addressing energy intake specifically, nutrition scientists need to move away from self-report approaches including NHANES, which may underestimate energy intake by up to 800 kcal per day (Dhurandhar et al., 2014). The message from this article is clear: nutrition researchers must continue to identify and develop objective forms of dietary assessment.

The primary criticism of subjective dietary assessment methodologies including 24-hour recalls, food frequency questionnaires (FFQs), and food records are whether these instruments reflect actual intake of both macronutrients and micronutrients (Hedrick et al., 2012; U.S. Department of Health & Human Services, 2014). Each of these methodologies has specific strengths and weaknesses; however, challenges with recall, determining correct portion sizes, and underreporting are



characteristic of all three (Hedrick et al., 2012). In nutritional epidemiology, such discrepancies can translate into a systematic or random measurement error of a particular dietary component and may have implications for estimating dietary associations with the disease outcome of interest (Heitmann & Lissner, 2007; Jenab, Slimani, Bictash, Ferrari, & Bingham, 2009).

Self-report of dietary intake by children is prone to misreport due to limitations of cognitive ability which can translate into difficulty remembering foods served (Livingstone, 2000; Moore, Tapper, Moore, & Murphy, 2008) and incorrect identification of foods (Livingstone, 2000). However, misreporting in children can also be attributed to other factors including classroom behaviors, attitudes, and socioeconomic status (Moore et al., 2008). When it comes to interventions, researchers should also be cognizant of self-report issues when designing the study. For example, fifth grade children attending the intervention school in an obesity prevention study systematically underreported dietary intake compared to the control school (Harnack et al., 2004).

Over-reporting of healthy foods, such as FV consumption, has been identified both 24-hour recalls (Hebert et al., 2008) and FFQs (Miller, Abdel-Maksoud, Crane, Marcus, & Byers, 2008). In one study, subjects who viewed “biased” prompts as part of a FFQ and subsequently reported consuming significantly more fruits and vegetables (~1.5 more servings) than control subjects without exposure to the prompt (Miller et al., 2008).

Underreporting of unhealthy foods has been identified in regard to fat intake in the diet (Hebert et al., 2008). Such systematic underreporting of fats, especially by

high-risk individuals, may affect disease association (Heitmann & Lissner, 2007). Underreporting has also been observed with sugar sweetened beverage (SSB) consumption when self-report was validated against Doubly Labeled Water (Emond, Patterson, Jardack, & Arab, 2014). This may have the effect of underestimating of the association between SSB intake and likelihood of being overweight or obese (Emond et al., 2014). In children, social desirability bias may result in omission of certain foods as evidenced by questionnaire completed by 9-11 year olds of breakfast items consumed (Moore et al., 2008). Children were more likely to omit unhealthy breakfast foods including sweet snacks and potato chips than healthy foods (Moore et al., 2008).

Alternatives for child report are proxy report by parents (Bornhorst et al., 2014; Orton, Szabo, Clare-Salzler, & Norris, 2008). Parent-reported FFQs assessed omega-3 and omega-6 polyunsaturated fatty acid intake in children (Orton et al., 2008) and parent proxies have also been used for 24-hour recalls to assess total energy intake (Bornhorst et al., 2014). To address children's challenge of food portion size estimation, new technologies are being developed including an interactive portion size assessment system (Foster, Hawkins, Simpson, & Adamson, 2014). This technology features digital images of foods to estimate served and wasted amounts and also links these to UK composition codes and weights (Foster et al., 2014). Such tools may encourage subject participation and the quality of the dietary assessment data (Foster et al., 2014).

## **Objective Dietary Assessment Methods**

### *Biomarkers: Doubly-labeled water*

One approach for identifying discrepancies between “reported” and “true” intake of macro and micronutrients is through validating these methodologies with an objective form of dietary assessment—a nutritional biomarker (Freedman et al., 2004; Willett, 1998). A nutritional biomarker can be simply defined as an indicator of dietary exposure and can comprise of a compound contained in a food and its corresponding metabolites (Kuhnle, 2012). The primary assumption of a biomarker is that it has a dose-response relation to diet (McKeown et al., 2001; Willett, 1998).

DLW, which measures energy expenditure in weight-stable subjects, is recognized as the gold standard for testing the validity of assessments of habitual energy intake (Schoeller, 2002; Wong et al., 2014). Using the principal of energy balance, energy intake can be deduced through the measurement of energy expenditure using DLW (Schoeller, 2002). DLW has been applied to an array of validation studies to ascertain whether different dietary assessment methodologies capture true energy intake.

A systematic review of 15 cross-sectional studies comparing dietary assessment methods with DLW in children less than 18 years of age indicated that energy underreporting was most associated with food records and ranged from 19%-41%. Energy over-reporting was anywhere from 2% to 59% and was characteristic of 24-hour recalls, diet history, and FFQs (Burrows, Martin, & Collins, 2010). An intriguing recent application of DLW was to assess dietary intake in pre-school aged children using parental proxies (Bornhorst et al., 2014). Bornhorst and colleagues

found that a 24-hour recall using proxy-reported energy intakes by parents was valid on the group level, but not the individual level (Bornhorst et al., 2014). DLW is a highly effective method for determining energy intake with benefits including reduced participant burden, lack of invasiveness, and opportunities for shipping samples (Wong et al., 2014). However, it is expensive and requires the use of specialized instruments (Wong et al., 2014). DLW is also limited to measuring energy expenditure in weight-stable individuals (Schoeller, 1999) and does not provide information regarding food or nutrient intake.

#### *Biomarkers: Strengths and limitations*

The usefulness and reliability of biomarkers from blood or other tissues varies from nutrient to nutrient (Willett, 1998). Like self-report dietary assessment methods, biomarkers are prone to misclassification and bias due to an array of issues including: sensitivity to intake, time integration, and the impact of non-dietary determinants on the biomarker (i.e. genetic, lifestyle, and environmental factors) (Hedrick et al., 2012; Kuhnle, 2012; Potischman, 2003; Willett, 1998). Moreover, there are factors beyond those corresponding to the study subject that can reflect methodological factors including specimen collection and storage, seasonality of foods containing the nutrient, time of day the sample is collected, contamination, and stability (Potischman, 2003; Willett, 1998). Additionally, the subject burden of many biomarkers needs to be considered including invasiveness (Hedrick et al., 2012). Less invasive approaches including the use of skin carotenoids as a biomarker for fruit and vegetable intake in children should be explored (Aguilar, Wengreen, Lefevre, Madden, & Gast, 2014).

The strength of biomarkers as an objective way to validate self-report based dietary assessment measures that are prone to measurement error cannot be underestimated (Prentice, Tinker, Huang, & Neuhouser, 2013). The potential for biomarkers to understand dietary patterns and nutritional status is a major strength of this method. Nutritional biomarkers have the capacity to objectively measure dietary patterns of over-reported “healthy” and under-reported “unhealthy” food groups such as sugar-sweetened beverages and high fat foods (Emond et al., 2014; Hebert, Clemow, Pbert, Ockene, & Ockene, 1995; Hebert et al., 2008; Miller et al., 2008). Such advancements will bolster the validation capabilities of nutritional biomarkers.

*Objective dietary assessment measures in the pre-school and school environment*

In the school setting, weighed plate waste (WPW) was previously considered the “gold standard” of dietary intake measurement. It has been applied to a plethora of research studies in the school setting. However, this method is both time and resource intensive (Comstock, St. Pierre, & Mackiernan, 1981) and the complexities of today’s school cafeteria environment exacerbate researchers’ ability to use this methodology.

Digital imaging (DI) is a method that involves taking digital images of food selections and plate waste and represents a promising alternative to WPW as it is less likely to disrupt the school cafeteria environment and it allows for additional time to estimate portion sizes (Williamson et al., 2003). In the laboratory setting, DI was found to be valid in comparison to WPW and direct observations (DO) (Williamson et al., 2003). The University of Vermont Dietary Assessment Team applied DI in the school environment at two Vermont elementary schools (grades 3-5) (Taylor, Yon, &

Johnson, 2014). DI was found to be a feasible, reliable, and valid measure of elementary school children's FV intake (Taylor et al., 2014). DI was a valid measure of FV consumption and was within 1.0g of WPW and not significantly different from WPW ( $p=0.56$ ). It was also determined that DI is a feasible and reliable method to measure children's FV consumption in comparison to WPW (Taylor et al., 2014).

In the pre-school setting, the validity and feasibility of a digital diet estimation method for children was explored in both Head Start centers during lunch and in the home setting. Similar to DI in the school setting, trained research staff took photos of selections of food, plate waste, and reference portions (Nicklas et al., 2012). The average correlation between weights estimated using reference images for the DI method and actual weights was 0.96 ( $P<0.001$ ) (Nicklas et al., 2012).

Other technologies in the school cafeteria include incorporating "smart cards" that link a food dataset with individual purchases to provide a nutrient analysis of selected foods (Lambert et al., 2005). However, the evident limitations of this approach are that it is limited to what is represented in the computer database for selection and cannot measure consumption or waste.

### **Engaging Non-researchers in Dietary Assessment**

The feasibility of DI was established using a team comprised of 15-20 undergraduate and graduate research assistants trained as part of a semester-long class (Taylor et al., 2014). Other studies using DI dietary assessment in the elementary school cafeteria environment also used researchers or clinicians to collect the data (Martin et al., 2014).

A limitation of using a trained university research team is the feasibility of collecting data remotely in large samples in geographically diverse settings. Previous studies using this methodology were conducted within one to two hours of the university (Taylor et al., 2014). One alternative to using a trained university research team is to engage school-based volunteers (i.e. parents or teachers) in data collection. Non-research professionals have been trained to enter data and demonstrated high inter-rater reliability in comparison to researchers in the school food environment using a computerized competitive food assessment tool (Bullock, Craypo, Clark, Barry, & Samuels, 2010). When assessing dietary intake, adult volunteers were trained and successfully captured digital images of meals (Daugherty et al., 2012).

One previous DI data collection approach that has not been validated in the elementary school cafeteria setting involves using a digital video camera with a fixed distance and angle and having the students place their tray on a mat to be photographed (Williamson et al., 2012; Williamson et al., 2007). However, the feasibility of this method may be limited in larger, fast-paced school cafeteria environments where there are multiple food stations and students quickly moving through the lines. The quality and validity of these data may be compromised if there are obstructions blocking the food items and if seconds are taken after the pre-image is captured. Previous work by our research team supports having trained research personnel on-site to ensure that quality DI data is collected and data collection does not affect the cafeteria environment, including lunch line traffic (Taylor et al., 2014).

## **Addressing FV Consumption Pre-School Aged Children**

### **Current Interventions**

The presentation and preparation of fruits and vegetables to pre-school children can affect consumption. For example, providing a variety of familiar FVs (Roe, Meengs, Birch, & Rolls, 2013), serving age-appropriate sized entrees (Savage, Fisher, Marini, & Birch, 2012), serving vegetables with dip (Savage, Peterson, Marini, Bordi, & Birch, 2013), and serving fruits (Harnack et al., 2012) and sometimes vegetables (Harnack et al., 2012; Spill, Birch, Roe, & Rolls, 2010) before the entrée can influence FV consumption. Fruit and vegetable-focused education and activities have had mixed success with this age group (Byrne & Nitzke, 2002; De Bock, Breitenstein, & Fischer, 2012; Gorelick & Clark, 1985; Herman, Nelson, Teutsch, & Chung, 2012; Natale et al., 2014; Piziak, 2012; Witt & Dunn, 2012) and vary in complexity from comprehensive and interactive curriculums (Gorelick & Clark, 1985; Herman et al., 2012; Natale et al., 2014; Witt & Dunn, 2012), to using picture or storybooks (Byrne & Nitzke, 2002), bilingual board games (Piziak, 2012), and involvement in meal preparation (De Bock et al., 2012).

Training mentors to educate and model different dietary and physical activity behaviors in children has been done using both adult (Haire-Joshu et al., 2010) and peer mentors (Hendy, 2002). In one study pre-school aged peer mentors were trained to influence novel food acceptance (Hendy, 2002). Hendy and colleagues used a “train the trainer” model with pre-school teachers who selected children who would likely adhere to the project. The teacher trained the peer pre-school mentors approximately 10 minutes before snack time, explaining that when the child mentor was served the featured meal



item to take a bite and exclaim “These X taste good!” The teacher practiced this sequence with the child a few times, providing verbal praise and recognition to the child. The child “model” was given a small toy as a reinforcement measure that he/she chose after the mealtime (Hendy, 2002). Adults have also been trained to serve as mentors of energy balance behaviors (both diet and physical activity) in high-risk children as part of a multi-component intervention (Haire-Joshu et al., 2010).

### **Importance of the Interpersonal Environment in Addressing FV Consumption**

Pre-school aged children have two primary interpersonal influences in the pre-school environment, including peers and teachers (Hendy, 1999; Hendy & Raudenbush, 2000; Natale et al., 2014). Some research findings suggest that teacher modeling does not significantly influence pre-school aged children’s consumption of fruits and vegetables (Hendy, 1999; Hendy & Raudenbush, 2000; Natale et al., 2014) and other food items (Hendy, 1999; Hendy & Raudenbush, 2000). One study found that “enthusiastic” teacher modeling may improve acceptance (Hendy & Raudenbush, 2000). Natale and colleagues’ suggestion for why parents were more effective models of FV consumption than teachers is that children look up to parents as role models, but regard teachers as educators only (Natale et al., 2014).

Peers, especially those of younger children (Birch, 1980) can also have an influence on the dietary behaviors of other children in different types of meal scenarios (Bevelander, Anschutz, & Engels, 2012a, 2012b; Bevelander, Lichtwarck-Aschoff, Anschutz, Hermans, & Engels, 2013; Finnerty, Reeves, Dabinett, Jeanes, & Voge, 2010; Greenhalgh et al., 2009; Hendy, 2002; Hendy & Raudenbush, 2000), including consumption of new and unfamiliar foods (Greenhalgh et al., 2009). Greenhalgh and

colleagues created a “novel blue food” out of potato bread and “quorn” and gave them the fictional names “fodrick” and “gwark” to be served as a side dish to five to seven year olds. They found that positive and negative modeling increased and decreased the food consumption, respectively (Greenhalgh et al., 2009). Peers can also influence the amount of palatable food consumed regardless of whether the child is overweight or normal weight (Bevelander et al., 2012b), even by the simple cue of reaching for a snack food (Bevelander et al., 2013). Peers are also effective models for lifestyle behaviors other than dietary intake, such as physical activity (Finnerty et al., 2010; Ginis, Nigg, & Smith, 2013).

### **Application of Social Cognitive Theory**

When designing an intervention targeting young children’s FV consumption, it is important to consider social, behavioral, and environmental factors. Social Cognitive Theory (SCT) specifies that the constructs of reciprocal determinism, behavioral capability, expectations, self-efficacy, observational learning, and reinforcements are central to an individual adopting a behavior (Bandura, 2012; U.S. Department of Health & Human Services, 2005). Children’s eating behavior is largely affected by the social context by which the foods are presented (Adnessi et al., 2005; Birch, Zimmerman, & Hind, 1980; Galloway et al., 2006). The constructs of observational learning, behavioral capacity, and reinforcements can be translated into techniques for peers or mentors to model and encourage positive FV consumption behaviors in pre-school aged children.

### **Social Norms**

Social norms play a tremendous role in the types and amounts of foods people consume (Bevelander et al., 2012b; Eisenberg, Neumark-Sztainer, Story, & Perry, 2005;

Lally, Bartle, & Wardle, 2011; Robinson, Thomas, Aveyard, & Higgs, 2014). For example, information that people consume large amounts of food is associated with higher food intake (Robinson et al., 2014). Lally and colleagues found that adolescents often have misconceptions about what their peers actually eat. Adolescents underestimated their peers' consumption of fruits and vegetables by 3.2 portions per week and how positive their peers' attitudes were towards fruits and vegetables. Moreover, sugar sweetened beverage consumption was overestimated (Lally et al., 2011).

The social context and climate of a meal may affect how dietary norms are actually exhibited as behaviors. For instance, social proximity can impact how social norms affect different behaviors (Cox & Bates, 2011). Also, eating norms can guide behaviors differently based on the importance of social approval and social desirability (Robinson, Benwell, & Higgs, 2013). This is salient to peer influence in a pre-school since children are together in meal environments (lunch and snacks). This interpersonal structure can affect the different ways that social norms translate into different mealtime behaviors.

Addressing dietary misconceptions through targeted educational strategies is an essential pre-requisite for an intervention addressing dietary behaviors where norms could have an impact. Social norms may have implications on the types of foods children select and consume and thus need to be considered when designing an intervention. Moreover, if socially developed children support dietary norms rather than deviate from them, it could potentially have a stronger influence on other children's eating behaviors.

## **YMCA Setting**

The YMCA has a widespread national presence making it an ideal partner for interventions that address youth behaviors such as physical activity and diet. The YMCA emphasizes, “Lasting personal and social change comes about when we all work together”. Child education and leadership is a central priority for the YMCA. For example, the YMCA’s afterschool program “Building Better Educated Leaders for Life (BELL)” reported that over 70% of students improved their social-emotional skills (YMCA, 2014a). These core values are relevant to our intervention in which afterschool program children will serve as mentors to encourage healthy behaviors in younger children. The YMCA also prioritizes the health and wellness of children through national initiatives including Healthy Kids Day<sup>®</sup> that over 1,500 Y’s across the country participate in (YMCA, 2014b).

Other researchers have collaborated with the YMCA to conduct interventions that align with the organization’s priorities for its community. McCormick and colleagues designed a community-based healthy weight intervention for children at the YMCA, which included counseling, nutrition education and physical activity with 43% (n=15 of 35) of the subjects experiencing clinically significant weight reductions (McCormick, Ramirez, Caldwell, Ripley, & Wilkey, 2008). Similar to our project, there have been efforts directed towards afterschool programs (Centers for Disease Control and Prevention, 2012). One project led by Harvard University established physical activity and nutrition standards for the program that resulted in improvements of the nutritional value of snacks and physical activity levels in participants (Centers for Disease Control and Prevention, 2012). Thus, a partnership with the YMCA

demonstrates promise as an easy to implement and sustainable initiative to bring children together and encourage positive dietary changes.

## **CHAPTER 2: When fruits and vegetables are optional, elementary school children choose processed over whole offerings**

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## **ABSTRACT**

### **Purpose/Objectives**

Increasing children's fruit and vegetable (FV) consumption is an important goal for the National School Lunch Program (NSLP). In 2012 the NSLP began requiring students to select a FV. The objective of this study was to compare children's FV choices in two school cafeteria environments a year before these new USDA regulations took effect.

### **Methods**

Elementary school (grades 3-5) children's FV choices were measured during Spring 2011 at two northeast schools (NES-A and NES-B) using three validated dietary assessment methods. NES-A had a self-serve salad bar, whereas NES-B served pre-portioned FV and pizza daily.

### **Results**

Of 555 trays assessed (n=284 NES-A, n=271 NES-B), 15.3% (n=85) had no FV selected. A higher percentage of trays from NES-A had no FV (23.6%, n=67) in comparison to NES-B (6.6%, n=18) ( $p<0.0001$ ). On average children selected more processed FV (PFV) (80.8g) than whole FV (WFV) (40.5g,  $p<0.001$ ). The mean amount of FV selected was lower in NES-A (111.4g) than NES-B (131.5g,  $p<0.01$ ). When trays without a FV were removed, quantities selected were not significantly different between schools ( $p=0.46$ ). For PFV, 100% fruit juice was on 41.4% of trays (n=230) and pizza was on 42.1% of NES-B trays (n=114). Trays with pizza or 100% fruit juice were less likely to have a WFV ( $p<0.001$ ,  $p<0.0001$  respectively).

### **Applications to Child Nutrition Professionals**

Children selected larger amounts of FV in a cafeteria environment that offered pre-portioned FV and pizza daily. Children were more likely to select juice and pizza than WFV. Promoting school children's selection and consumption of whole rather than processed FV may help school nutrition programs comply with NSLP sodium and saturated fat requirements. Identifying healthier PFV recipes and understanding what WFVs students prefer are strategies schools can use to improve FV choices.

## **INTRODUCTION**

The childhood obesity epidemic is unquestionably among the top public health issues facing the U.S. (Centers for Disease Control and Prevention [CDC], 2012b). In recent years however, areas of the country have seen slightly decreased rates of childhood obesity (Robert Wood Johnson Foundation [RWJF], 2012). By implementing comprehensive plans that include the school food environment, selected cities and states have demonstrated that steadfast efforts are integral to reducing this epidemic (RWJF, 2012).

Fruit and vegetable (FV) consumption is a central focus of efforts to support healthy dietary behaviors in children. FVs confer health benefits, including intake of essential nutrients, reduced risk of chronic diseases, and weight maintenance (U.S. Department of Agriculture [USDA] & U.S. Department of Health and Human Services, 2010). Unfortunately, the majority of children do not consume the recommended amounts of FVs (CDC, 2012a). Children's preferences for FVs in the school cafeteria are an important determinant of consumption (Baxter & Thompson, 2002). To improve children's consumption of FVs, interventions should focus on meals served in schools since children may consume up to half of their calories in this setting (Schanzenbach, 2009).

Participation of more than 30 million children in the National School Lunch Program (NSLP) provides an opportunity to shape healthier food choices (Turner & Chaloupka, 2012). NSLP participants consume higher amounts of fruits or 100% fruit juice as well as vegetables (though predominantly potatoes) compared to non-program



participants (Story, Nanney, & Schwartz, 2009). In Fall 2012, the NSLP implemented new regulations. Revisions included calorie maximums and changes to the "Offer Versus Serve" (OVS) rule. In the past, students were permitted to decline any two of the five meal components, including a fruit or vegetable (USDA, 2013). Students are now *required* to select a fruit or vegetable in an effort to increase FV consumption (USDA, 2012b).

During the initial implementation period, the new NSLP regulations were met with some resistance. The USDA/Food and Nutrition Service (USDA/FNS) sought feedback from school nutrition experts, who reported operational challenges related to regulations for meat/meat alternates and grains (USDA, 2012a). The USDA/FNS responded by repealing weekly maximums for grain and proteins while maintaining the calorie limits (USDA, 2012a). There were additional concerns regarding how the guidelines may affect children's FV consumption and plate waste. Therefore, the impact of schools' and students' adjustment to the new regulations on future policy changes remains uncertain. It is important to understand FV choices among school children who voluntarily selected FVs because this provides insight into what students prefer. This information is timely and can help inform what schools offer for FV under the new regulations.

The objective of this study was to evaluate children's FV choices in an "Offer versus Serve" cafeteria environment at two Northeast elementary schools (grades 3-5) using three validated dietary assessment methods.

## **METHODOLOGY**

### **Sample**

School nutrition directors from two Northeast school districts were contacted during October 2011 and two elementary schools (NES-A and NES-B) within those districts (grades 3-5) were recruited for the study. The districts and schools were selected based on their varied demographics and cafeteria environments (Table 1). The University of Vermont Institutional Review Board designated the protocol as exempt since cafeteria trays were the unit of analysis and no identifying information on school children was collected. FV choice data were gathered in 2012 between January and May. Any student participating in the school lunch program was eligible to be included in the study. Students who brought lunch from home were not included. A total of 555 trays (n=284 NES-A, n=271 NES-B) were assessed across 10 school visits (5 visits per school).

### **Data Collection**

Children's FV choices were measured as part of a feasibility and validation study comparing three dietary assessment methods: direct observation (DO), digital imaging (DI), and weighed plate waste (WPW) (Taylor, 2013; Taylor, Yon, & Johnson, 2013a; Taylor, Yon, & Johnson, 2013b). Feasibility, reliability, and validity of DI were separately assessed as FV choice data were collected. Prior to collecting these data, DI had not yet been validated in the school cafeteria setting. FV choice data were collected by a research team comprised of two graduate and 19 trained undergraduate students. DI and DO were validated in the cafeteria environment against the gold standard WPW

method prior to FV choice assessment. DI and DO estimations for group mean fruit, vegetable, and combined FV consumption per tray were within three grams of WPW, and, with the exception of DO estimations for fruit ( $p<0.05$ ), were not significantly different from WPW (Taylor, 2013; Taylor, Yon, & Johnson, 2013a; Taylor, Yon, & Johnson, 2013b).

Before each school visit, colored stickers with a unique identification code were adhered to lunch trays. Fifty to 80 trays were distributed with a target of collecting 30-40 trays (10-20 trays per lunch period) for data collection purposes (Graves & Shannon, 1983; Templeton, Marlette, & Panemangalore, 2005). More trays were distributed than the target sample size because it was anticipated that, given challenges of collecting trays in a busy school environment, some of these trays would not be successfully collected. FV offerings were identified by checking school menus and consulting with cafeteria staff. Baseline FV weights for pre-portioned items were determined using an average weight of five randomly selected samples of each food item. For items served in variable portion sizes, weights were determined for typical serving sizes (e.g., one-half cup). For combination or processed foods, recipes were obtained from the foodservice staff and the percentage of FV was calculated by weight.

Children's selections of pre-portioned items were counted, and selections of items with variable portion sizes were weighed to the nearest gram (while using WPW) or visually estimated to the nearest one-quarter cup (while using DO or DI). Research staff stood near exits to the food service area to record food selections or collect images of trays. While using DI, images were taken with Canon PowerShot ELPH 300 HS digital

cameras (Canon, Melville, NY) held at approximately 75° and 18-24 inches above the lunch tray, without the assistance of tripods, while children held their trays. Research staff visually estimated selections after they were familiarized with standard volumes of each FV item, which were viewed in real-time (using DO) or digitally within a library of reference images (using DI). Selection estimations using DO or DI were averaged when items were assessed by more than one staff member.

### **FV Choices and Amount Selected**

Research team members determined FV choices and the weight (g) selected for each food item using baseline FV data. FVs were further categorized based on whether they were a whole FV (WFV) or a processed FV (PFV). PFVs (pizza, tomato-based entrees, soup) were defined in this study as 100% fruit juice and those that were prepared by cooking the FV with additional ingredients. WFV categories including steamed vegetables, alternating salad bar vegetables, etc. were further assigned as appropriate. Trays that had no FV selected were coded as no FV.

### **Statistical Analyses**

Descriptive statistics were used to characterize FV selection at both schools. FV choices were assessed as the percent of trays with a specific food item present, among those items served during the majority of visits (>3, Fig. 1). Grams of FVs (WFV, PFV, and total FV) were calculated by multiplying the number of units or cups selected of each FV item by its respective weight. To further assess FV choices, two-sample *t*-tests were used to compare grams of WFV and PFV selected between the two schools. The data were

analyzed using Stata/SE (Version 12, 2011, College Station, TX) with  $p=0.05$  for significance.

## **RESULTS AND DISCUSSION**

The cafeteria environments of the two schools varied in several distinctive ways including, 1) the presence of a salad bar (NES-A), 2) FV serving style (NES-A self-serve, NES-B pre-portioned) and, 3) how often pizza was served (NES-A weekly, NES-B daily) (Table 1). Of 555 trays assessed ( $n=284$  NES-A,  $n=271$  NES-B), 15.3% ( $n=85$ ) had no FV selected. A higher percentage of trays from NES-A had no FV (23.6%,  $n=67$ ) in comparison to NES-B (6.6%,  $n=18$ ) ( $p<0.0001$ ). The mean amount of FV selected was lower in NES-A (111.4g) than NES-B (131.5g,  $p<0.01$ , Table 2). When trays without a FV were removed, quantities selected were not significantly different between the two schools ( $p=0.46$ ).

Recently, there have been efforts made to introduce salad bars in schools to promote FV selection and consumption (Harris et al., 2012). Self-serve salad bars do not necessarily improve FV selection when compared to pre-portioned FV serving style (Adams, Pelletier, Zive, & Sallis, 2005). Adams et al. (2005) found no significant difference between mean FV selections in cafeterias that served pre-portioned FV ( $112\pm70$ g) and self-serve salad bars ( $104\pm86$ g). In this study, fewer students at the self-serve salad bar cafeteria selected FVs compared to the students in the pre-portioned FV cafeteria. It is important to consider the role that the cafeteria environment has in children's FV choices.

Children selected more PFV on average (80.8g) than WFV (40.5g,  $p<0.001$ ). Students at NES-A chose fewer WFV (mean=36.2g) compared to students at NES-B (mean=44.9g,  $p<0.05$ , Table 2). The highest percentages of WFV selected at NES-A included: apples (21%), carrots (11%), and alternating salad bar vegetables (7%). The most popular WFV choices in the NES-B cafeteria were steamed vegetables (15%), fruit cups (12%), and vegetables with dip (8%) (Fig.1). The manner in which fruits and vegetables are presented influences children's preferences (Olsen, Ritz, Kramer, & Møller, 2012; Swanson, Branscum, & Nakayima, 2009; Wansink, Just, Hanks, & Smith, 2013). Olsen et al. (2012) found that children preferred cut vegetables and vegetables served with dip. Slicing fruits such as oranges (Swanson et al., 2009) and sometimes apples (Swanson et al., 2009; Wansink et al., 2013) instead of serving them whole can increase students' fruit selection and consumption. In this study the students' preferences for WFVs such as carrots, vegetables with dip, and alternating salad bar vegetables underscores the importance of serving FVs that are prepared in a way that students prefer (Cullen et al., 2003).

PFV choices were also lower in NES-A compared to NES-B at 75.2g and 86.6g, respectively ( $p<0.05$ , Table 2). The highest percentage of FV choices overall were PFV in the form of 100% fruit juice and pizza/tomato-based entrees (Fig. 1). One hundred percent fruit juice was present on 41% of trays ( $n=230$ ). During two of the trips to NES-A, tomato-based entrees (lasagna and meat sauce) were on 63% ( $n=74$ ) of the trays. Across all five of the NES-B visits, pizza was on 42% ( $n=114$ ) of trays. Pizza and tomato-based entrees were significant contributors to children's FV selection. Strategies

to reduce childhood obesity should focus on replacing energy-dense foods with fiber-rich, less energy dense foods (Gidding et al., 2006). Tomato paste in pizza and tomato-based entrees can contribute to recommended servings of vegetables (USDA, 2012b). However, these foods are often also sources of excessive saturated fat, sodium and calories, conflicting with the positive benefits that FVs offer in addressing childhood obesity.

PFV selection was associated with other mealtime FV choices. Students who selected pizza (n=114) were less likely to also select a WFV (mean=31.1g) compared to students who did not select pizza (n=157, mean=54.6g,  $p<0.001$ ). At both schools, mean WFV selection among students who did not select 100% fruit juice (n=325) was twice (mean=51.5g) that of students who selected juice (n=230, mean=24.8g,  $p<0.0001$ ). Compared to whole fruits, 100% fruit juice is not nutritionally superior nor does it contain fiber (Committee on Nutrition, 2001). Giddings et al. (2006) recommended that children between 7 and 18 years of age limit their 100% fruit juice consumption to 8 to 12 oz. per day. Moreover, consistent consumption of 100% fruit juice in place of whole fruit does not encourage dietary behaviors promoting whole fruits (Committee on Nutrition, 2001). In this study, PFV constituted the majority of children's FV selection. If children are required to select a FV at lunch, it is important to identify ways to help children develop preferences for WFV (USDA, 2012b).

## **CONCLUSIONS AND APPLICATION**

The objective of this study was to compare children's FV choices in two school cafeteria environments a year before new USDA regulations took effect. As part of the updated meal pattern, students are now required to select a FV at lunch. In a FV-optional

meal environment, 15% of children did not select a FV. A significantly higher number of students did not choose a FV in the school that had a salad bar, was self-serve, and served pizza weekly. FV choices were primarily driven by PFV in the form of 100% fruit juice, pizza, and tomato-based entrees. Lunch trays with those items selected were also less likely to have a WFV present.

There were a few limitations that affect the generalizability of this study's findings. First, because this study was conducted at two schools where the majority of the children were Caucasian, the study findings might not be applicable to schools with more ethnically diverse populations. Data collection days were conducted on a consistent day during the week. Therefore, children's FV choices on non-data collection days could be different than the days the research team visited the schools. However, the study findings are strengthened by the number of data collection days (five visits per school).

While children are now required to select a FV during lunch, they may continue to select processed over whole varieties. Identifying alternative PFV recipes (i.e. pizza and lasagna) that deliver nutritional value without excess saturated fat, sodium and calories could be an effective strategy to incorporate FVs into children's diets. The new NSLP regulations offer schools and food service providers an opportunity to reformulate pizza recipes and still address students' preferences. The benefits of school pizza reformulations that meet the USDA's Healthier US School Challenge (HUSC) criteria on nutrient intake include significantly decreased levels of daily energy, carbohydrate, total fat, saturated fat, cholesterol and sodium in children and adolescents (Hur, Marquart, & Reicks, 2013). Additionally, commercial pizza companies have made a concerted



effort to offer pizza for school use with lower sodium cheese and crusts containing higher percentages of whole-wheat flour.

Understanding which WFVs children prefer, as well as how those WFVs are offered (cut versus whole) can prevent waste. While salad bars are thought to promote school children's selection and consumption of WFVs, the overall cafeteria environment may be important to take into consideration. Simple strategies can be incorporated to make healthy foods more convenient and appealing, such as placing fresh fruits next to the cash register or labeling vegetables with descriptive names (Hanks, Just, & Wansink, 2013). Promoting school children's selection and consumption of whole rather than processed fruits and vegetables may help school nutrition programs comply with the NSLP sodium and saturated fat requirements.

Schools can explore programs such as Farm to School and school gardens to complement their meals. Farm to School has gained national recognition for its potential to positively influence children's eating behaviors and offers promising tools to increase children's FV consumption (National Farm to School Network, 2013; Vermont FEED, 2011). School nutrition professionals can apply these findings to their cafeteria operations and consider the variety and presentation of FVs offered to students, as well as recipes used, to support children's selection and consumption of FVs.

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## TABLES

Table 1. <i>Demographic and cafeteria environment characteristics of two Northeast elementary schools</i>		
Demographic Characteristics	NES-A <sup>a</sup>	NES-B <sup>b</sup>
Grade 3-5 enrollment (n)	160	467
Student eligibility for free or reduced price lunch (%)	35	52
Demographics (%)		
White	84	91
Non-white <sup>c</sup>	16	9
Farm-to-school program	Yes	No
Cafeteria Environment Characteristics		
Entrée stations	Featured entrée, cold sandwiches	Featured entrée, pizza, deli, entrée salad, grill
Salad bar	Yes	No
FV serving style	Self-served	Pre-portioned
Pizza	Served weekly <sup>d</sup>	Served daily

<sup>a</sup> NES-A = Northeast Elementary School-A

<sup>b</sup> NES-B = Northeast Elementary School-B

<sup>c</sup> Non-white = Hispanic, Asian, Other

<sup>d</sup> Pizza was a once-per-week entrée option but was not served during any data collection days

Table 2. Comparison of fruit and vegetable selection between two Northeast elementary schools			
	NES-A (n=284) <sup>a</sup> <i>M ± SE</i>	NES-B (n=271) <sup>b</sup> <i>M ± SE</i>	<i>t</i>
Total fruits and vegetables (g)	111.4 ± 5.6	131.5 ± 4.2	2.9*
Whole fruits and vegetables (g)	36.2 ± 3.4	44.9 ± 3.5	1.8*
Processed fruits and vegetables (g)	75.2 ± 4.7	86.6 ± 4.1	1.8*
	NES-A (n=217) <sup>a,c</sup> <i>M ± SE</i>	NES-B (n=253) <sup>b,c</sup> <i>M ± SE</i>	<i>t</i>
Total fruits and vegetables adjusted (g)	145.8 ± 5.5	140.9 ± 3.9	0.75
Whole fruits and vegetables adjusted (g)	47.4 ± 4.2	48.1 ± 3.7	0.12
Processed fruits and vegetables adjusted (g)	98.4 ± 5.2	92.8 ± 4.1	0.85

<sup>a</sup> NES-A = Northeast Elementary School A

<sup>b</sup> NES-B = Northeast Elementary School B

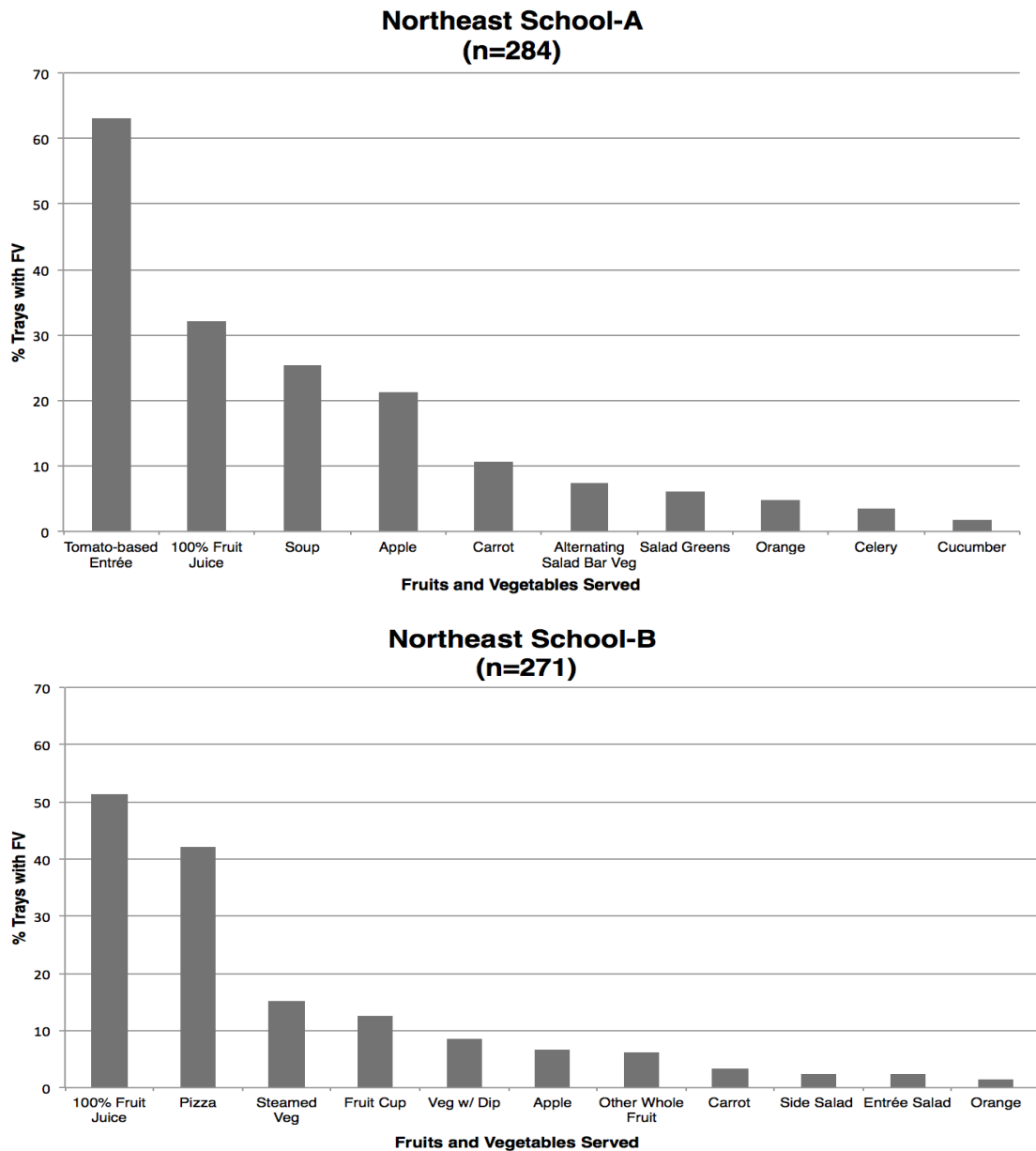
<sup>c</sup> Excludes trays with no FV selected (67 trays at NES-A and 18 trays at NES-B)

\* $p < 0.05$

\*\* $p < 0.001$

## FIGURE

**Figure 1.** Percent of elementary school lunch trays with a fruit or vegetable selected during the majority of trip visits (>3 times) for NES-A<sup>a</sup> and NES-B<sup>b</sup>



<sup>a</sup> NES-A = Northeast Elementary School-A

<sup>b</sup> NES-B = Northeast Elementary School-B

<sup>c</sup> Tomato-based entrees included meat sauce and lasagna (each served two times total).

<sup>d</sup> Alternating Salad Bar Veg included broccoli, mushrooms, black beans, chickpeas, root vegetables, peppers.

<sup>e</sup> Steamed Veg included corn, broccoli, cauliflower, peapods.

<sup>f</sup> Other Whole Fruit included grapes, pears, kiwis, bananas

### **CHAPTER 3: Elementary school children select more fruits and vegetables but consume less when required with school lunch**

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## **ABSTRACT**

Increasing children's fruit and vegetable (FV) consumption is an important goal of the USDA's National School Lunch Program. Since 2012, the USDA's requirement that children select a FV at lunch as part of the reimbursable school meal has been met with concern and evidence of food waste. Elementary school children's FV selection, consumption and waste were compared before (10 school visits, tray observations n=498) and after (11 school visits, tray observations n=944) the implementation of this requirement using validated dietary assessment measures. More children selected FV in higher amounts when FV were required compared to when they were optional (0.69 cups vs. 0.89 cups,  $p<0.001$ ); however, consumption decreased slightly (0.51 cups vs. 0.45 cups,  $p=0.01$ ) and waste increased (0.25 cups vs. 0.39 cups,  $p<0.001$ ). More exposure to FV in schools through programmatic efforts, as well as in the home environment, may help familiarize children with FV offerings and encourage consumption.

## **INTRODUCTION**

The majority of US children do not consume recommended amounts of fruits and vegetables (FV).<sup>1</sup> Increasing children's consumption of FV is an important goal of the National School Lunch Program which feeds nearly 31 million children each school day.<sup>2</sup> As of the 2012 school year, the United States Department of Agriculture (USDA) requires school children to select either a fruit or a vegetable with a reimbursable meal.<sup>3</sup> The implementation of this requirement was immediately met with concerns surrounding operational challenges, FV waste, and increased costs.<sup>4</sup> Two years later, school districts and states have reported increased waste by students.<sup>5,6</sup> In a recent survey completed by school nutrition directors (n=240), over 80 percent subjectively reported an increase in the amount of FV (especially vegetables) wasted by students.<sup>6</sup> However, there are a limited number of studies using rigorous, validated dietary assessment methods to measure school children's FV selection, consumption, and waste.<sup>7,8</sup> Such studies are critical to inform and evaluate interventions aimed at increasing children's FV consumption. The aim of this study was to compare children's FV selection, consumption and waste using validated dietary assessment methods when FV were optional in comparison to when they were required with school lunch by the USDA.

## **METHODS**

Two northeastern elementary schools (84-90% Caucasian) were enrolled in the study. Both schools had 40-60% of children qualifying for free or reduced meals, a marker for low socio-economic status. Data were collected as part of a larger study to validate the use of digital imaging to accurately measure children's FV consumption.<sup>9</sup> Random samples of lunch trays were collected from third, fourth and fifth grade children

with no identifying information collected from students. Uniquely numbered and colored stickers were adhered to all lunch trays and one color was observed at each visit. The purpose of the stickers was to identify trays from the 3<sup>rd</sup>-5<sup>th</sup> grade students that may have been mixed with trays from students in other grades and to randomly select trays from the target sample for the feasibility of data collection. Students' selection, consumption and waste of FV were objectively measured using validated methods (digital imaging, direct observation and weighed plate waste)<sup>9</sup> when FV were optional in spring 2012 (10 visits, tray observations n=498) and again the following school year in spring 2013 after the USDA rule was implemented and FV were required (11 visits, tray observations n=944). The University's Institutional Review Board approved the study and waived written consent; however teachers, staff, school administrators and parents were notified.

FV consumption was measured based on food selections (mean serving weights) and plate waste for each FV item per tray. All FV offered on the lunch menu were included in these estimates (whole FV; 100% fruit juice; FV in mixed dishes such as lasagna, pizza and soup). The feasibility, reliability and validation of the three dietary assessment methods have been previously published.<sup>9</sup> For weighed plate waste, FV were weighed to the nearest gram and converted to cups. For direct observation and digital imaging, a six-point scale was used to estimate the percentage consumed.<sup>10</sup> FV selections were estimated by counting the number of servings selected of each FV item served in standardized portions such as vegetable soup or baby carrots. FV items served in variable portion sizes such as salad greens were weighed and converted to cups (weighed plate waste) or estimated to the nearest one-quarter cup (direct observation, digital imaging). For weighed plate waste and direct observations, selections were determined before

children exited the lunch line, whereas digital imaging selections were determined by referencing images of FV in various portion sizes. To assist with estimating FV selection and percentage consumed for the direct observation method, research associates stood near the cashier stations and observed the amount of FV selected on targeted trays by counting the number of servings taken of FV items served in standardized portions and visually estimating selections of salad greens to the nearest one-quarter cup. With digital imaging, research associates compared tray selections and plate waste to reference images of standard serving sizes of each FV item. Selection, consumption and waste were calculated for all FV on each student's tray. We used chi-squared tests to compare children's selection of no FV, both FV, fruit only, and vegetable only. Independent sample *t*-tests were used to compare children's total FV selection, consumption and waste before and after the new USDA rule. All analyses were 2-tailed tests and performed using SPSS (version 21.0; SPSS Inc.).

## RESULTS

When FV were optional, 15.7% (95% CI: 8.6-22.8) of lunch trays did not contain FV, compared to 2.5% (95% CI: 0-5.5) when required ( $p<0.001$ ) (Figure 1). When required to select FV, the mean amount of FV on children's trays increased by 0.20 cups ( $p<0.001$ ) (Table 1). When trays were excluded where no FV were selected (pre and post new rule), there was a slight increase in the mean amount of FV placed on lunch trays once required (0.09 cups,  $p=0.001$ ) (Table 1).

Research associates could not determine consumption for 2% and 9% of lunch trays before and after the new rule respectively, due to missing evidence from inedible food portions or visual obstructions on the trays. While the amount of FV selected

increased when children were required to include FV on their lunch trays, more children consumed none of their selections (4% FV optional vs. 12% FV required,  $p<0.001$ ). On average, children consumed less FV (0.06 cup or ~1 tablespoon,  $p=0.01$ ) and wasted more (0.14 cup or ~2 tablespoons,  $p<0.001$ ) when FV were required compared to when they were optional (Table).

## **DISCUSSION**

Children consumed less FV and wasted more during the school year immediately following the implementation of the USDA rule that required them to take one fruit or vegetable at lunch. Average waste increased from 1/4 cup to more than 1/3 cup/tray, with ~1/8 cup/tray more FV discarded or a total of ~56 cups/day per school (based on an average of 400 lunches served/day). In the current study, 2.5% of students did not have a FV on their tray under the new requirements. It is possible a few students may have proceeded through the lunch line without being reminded by cafeteria personnel to go back and select a FV.

Increased FV waste<sup>11-12</sup> and decreased consumption<sup>8</sup> following the new USDA rule has been corroborated by other studies of elementary school children's food consumption. However, there have been some promising findings regarding the impact of the new USDA rule on children's FV consumption, including an increased percentage of students who consumed at least one serving of FV in a sample of three schools (20% FV optional vs. 28% FV required,  $p<0.01$ ).<sup>12</sup> The new USDA regulations not only require children to select a FV but also require schools to offer a greater variety of vegetables.<sup>3</sup> Cohen and colleagues reported that though the percentage of trays with a vegetable did not increase in 3<sup>rd</sup> through 8<sup>th</sup> grade elementary school children after the new rule,

vegetable consumption increased (0.13 cup vs. 0.30 cup,  $p < 0.0001$ ).<sup>7</sup> Children entering elementary school under the new USDA rule may respond better to the FV requirement. Under the new requirement younger children (grades 1-3) were found to consume more FV when required compared to older children (grades 4-5).<sup>8</sup> Adjustment to the new requirement may take time, especially since older children were accustomed to having the option whether or not to choose a FV.

A limitation of this study is that it only assessed differences in mean FV selection, consumption, and plate waste but not individual consumption. However, this is consistent with other studies that assessed the impact of the USDA rule on changes in students' school meal consumption behaviors.<sup>7-8,11-12</sup> Future studies could be conducted to better understand how to impact individual-level responses to changes in FV offerings. Another study limitation is that though the research team made every effort to unobtrusively collect tray data and not disturb the cafeteria environment, the presence of the research team may have biased students' FV selection and consumption behavior. Finally, the current study assessed FV consumption behavior in two northeastern elementary schools and therefore may not be generalizable to schools in different regions of the country. There are other characteristics including sociodemographic and cafeteria environmental factors that also may affect FV consumption behaviors.

In the current study, children's increased selection of FV may have been influenced by having more choices. However, while children were willing to select FV in larger portions, it may take time and repeated exposure to the new foods for children to become familiar with and develop preferences for the FV offerings.<sup>13</sup> Since more children did not even taste the FV they chose at lunch when required in the current study,

strategies are needed to encourage children to try unfamiliar FV they select. Children's existing FV preferences should also be supported.<sup>14</sup> It is important to ensure that FV offerings are available that children may already enjoy. However, since children prefer FV in the form of 100% fruit juice or mixed-dishes such as pizza or lasagna<sup>14</sup>, additional factors such as the types of whole FV offered and how they are prepared should also be considered.<sup>15-18</sup> Cutting up vegetables and serving them with dip<sup>15,16</sup>, slicing fruits such as oranges<sup>17</sup>, and apples<sup>17,18</sup> can influence students' FV selection and consumption.

Changes to school meal policies may reinforce positive behaviors in children, such as the "Smart Snacks in Schools" policy, which sets maximums on the amount of calories, salt, sugars, and fat contained in school snacks and promotes FV as one of the main ingredients.<sup>19</sup> Beyond the cafeteria, schools can explore programs such as Farm to School to complement their meals. Farm to School has gained national recognition for its potential to positively influence correlates of children's FV consumption behaviors such as attitudes, knowledge, and exposure through strategies such as gardening, cooking, or taste-testing.<sup>20,21</sup> Exposure to Farm to School programming was associated with increased FV consumption among participants who initially had the lowest FV intake.<sup>21</sup>

Strategies extending to the home environment should be considered as well since more frequent exposure to FV at home may result in children consuming a variety of FV at school.<sup>22</sup> These findings support the importance of public health practitioners addressing the environmental, home and personal factors that encourage children's FV consumption. While these data from one geographic area may not be generalizable to other regions, the measures of consumption and waste were based on validated, objective measures.<sup>9</sup> Furthermore, the findings are consistent with those from other parts of the

country where requiring a child to select a FV also corresponded with decreased consumption<sup>8</sup> and increased food waste.<sup>11-12</sup> Future research should explore barriers to consuming FV during school lunch and how offerings could better align with children's taste preferences.

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## TABLE

Table 1. Elementary schoolchildren's (grades 3–5) selection, consumption, and waste of fruit and vegetables at two northeast elementary schools during school lunch before (spring 2012) and after (spring 2013) implementation of updated National School Lunch Program regulations

<i>Variable</i>	<i>Spring 2012 N (percent)</i>	<i>Spring 2013 N (percent)</i>	<i>Percent change</i>	<i>P-value</i>
Total trays observed	498 (100)	944 (100)		
Trays with any FVs	419 (84)	919 (97)	13.3	<0.001
FV CBD trays <sup>a</sup>	38 (2)	85 (9)	NA	NA
	<i>Cups<sup>b</sup> Mean (95% CI)</i>	<i>Cups<sup>b</sup> Mean (95% CI)</i>	<i>Percent change</i>	<i>P-value</i>
All trays				
FV selected <sup>c</sup>	0.69 (0.63, 0.73)	0.89 (0.85, 0.92)	29.0	<0.001
FV consumed <sup>d</sup>	0.51 (0.47, 0.54)	0.45 (0.42, 0.47)	–11.8	0.01
FV wasted <sup>d</sup>	0.25 (0.21, 0.28)	0.39 (0.36, 0.42)	56.0	<0.001
Only trays with any FV selected <sup>c</sup>				
FV selected <sup>f</sup>	0.82 (0.76, 0.86)	0.91 (0.87, 0.94)	11.0	0.001
FV consumed <sup>g</sup>	0.52 (0.48, 0.54)	0.45 (0.42, 0.47)	–13.5	0.004
FV wasted <sup>g</sup>	0.25 (0.22, 0.28)	0.39 (0.36, 0.42)	56.0	<0.001

<sup>a</sup>CBD represents trays for which data could not be determined due to missing evidence from inedible food portions or visual obstructions on the trays.

<sup>b</sup>Because consumption and waste were unable to be determined for 2%–9% of lunch trays, the summed value in cups does not equal the selected amount of FVs.

<sup>c</sup>Includes all observed lunch trays with and without FVs selected (498 trays before and 944 trays after implementation of updated NSLP regulations)

<sup>d</sup>Includes all observed lunch trays with and without FVs selected (417 trays before and 862 trays after implementation of updated NSLP regulations)

<sup>e</sup>Excludes lunch trays with no FV selections

<sup>f</sup>Includes only lunch trays where children selected FVs (419 trays before and 919 trays after implementation of updated NSLP regulations)

<sup>g</sup>Includes only lunch trays where children selected FVs (410 trays before and 862 trays after implementation of updated NSLP regulations)

FV = fruit and vegetable

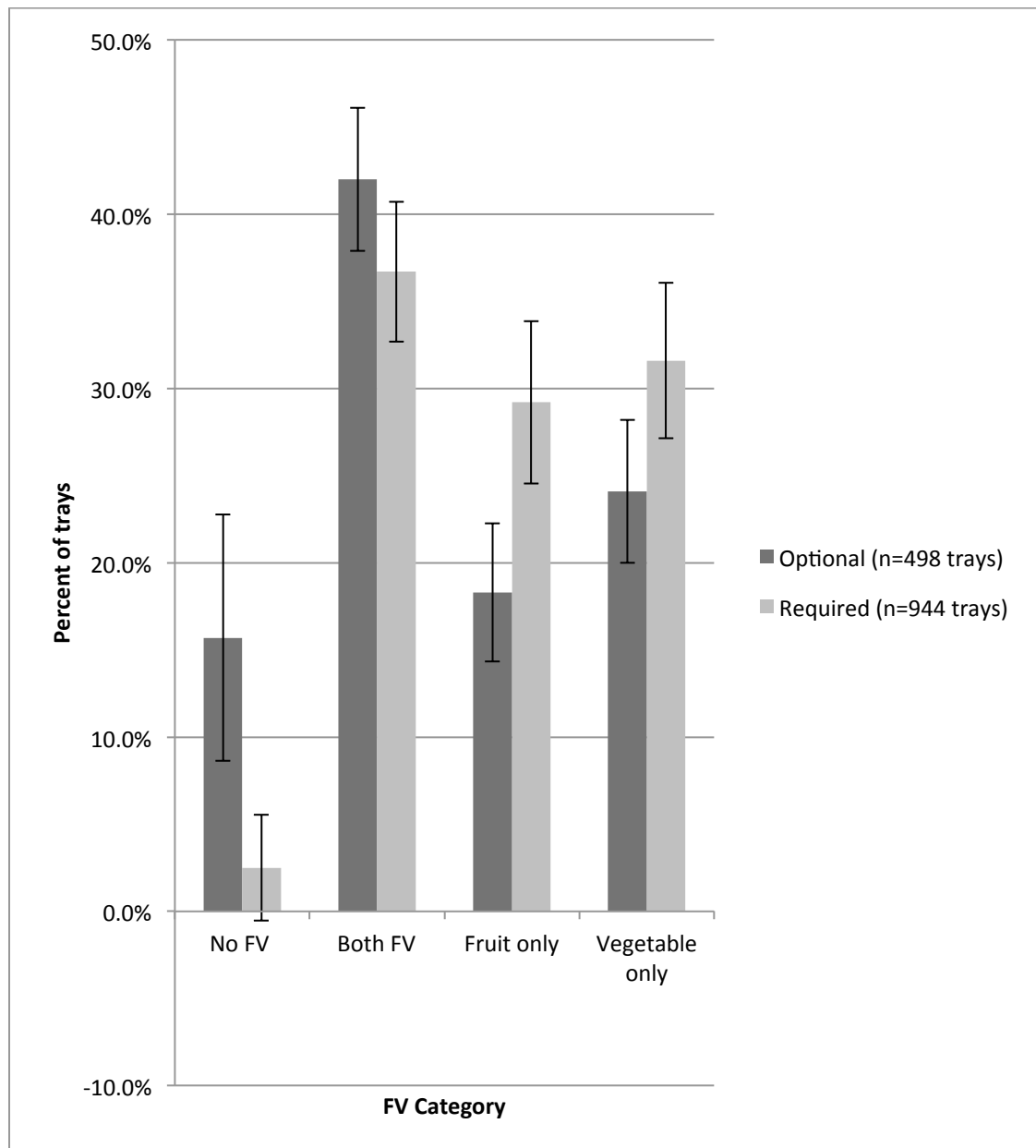
CBD = could not be determined

NA = not applicable

NSLP = National School Lunch Program

## FIGURE

Figure 1. Percentage of elementary schoolchildren's (grades 3–5) lunch trays with fruit and/or vegetables when optional (spring 2012, n=498) vs. when required (spring 2013, n=944) at two northeastern elementary schools



\*The lines that extend from each bar shows the 95% confidence intervals

**CHAPTER 4: The feasibility of teacher and parent volunteers collecting digital image data of children's fruit and vegetable consumption during school lunch.**

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## ABSTRACT

**Objective:** Compare the feasibility of digital imaging (DI) data collection by a university-based dietary assessment team (UDAT) to a parent volunteer dietary assessment team (PDAT) and a teacher dietary assessment team (TDAT) during lunch.

**Design:** Mixed methods including focus groups.

**Setting:** Two Northeast Elementary Schools (NES).

**Participants:** Parents (n=5, PDAT) and elementary school teachers/school principal (n=4, TDAT)

**Intervention:** Three-hour DI training workshop conducted at NES.

**Main Outcome Measures:** Total number of DI pairs collected out of the total number of eligible DI pairs (based on the number of lanyards distributed) across all data collection days for each of the three teams. PDAT and TDAT perceived barriers and facilitators of the DI data collection process.

**Analysis:** Binary logistic regression analyzed the feasibility of collecting usable DI pairs. Significance was set at  $P < .05$ . Focus group was audio-recorded, transcribed, and analyzed using thematic analysis.

**Results:** At NES-A, the PDAT was less proficient at collecting DI pairs (74.1%, n=218 of 294 LD) than the UDAT (81.9%, n=262 of 320 LD,  $P < .05$ ). At NES-B, the TDAT was better able to capture DI pairs (95.9%, n=257 of 268 LD) than the UDAT (91.3%, n=366 of 401 LD,  $P < .05$ ).

**Conclusions and Implications:** Teachers may be better at collecting DI dietary assessment data than parent volunteers and university researchers.

## INTRODUCTION

The majority of US children do not meet national recommendations for fruit and vegetable (FV) consumption.<sup>1</sup> While whole fruit consumption increased between 2007-2010, vegetable consumption remained unchanged with potatoes contributing approximately one-third of intake.<sup>2</sup> FV offer numerous health benefits including intake of critical shortfall nutrients, reduced risk of chronic diseases, and weight maintenance.<sup>3</sup> Identifying approaches to increase children's consumption of a variety of FV has become a public health priority and an objective of the National School Lunch Program which feeds 30 million children each school day.<sup>4</sup>

Digital imaging (DI) has been established as a feasible, reliable, and valid measure of elementary school children's FV intake.<sup>5</sup> This dietary assessment method involves using a university-based trained research team to capture digital images of food selections and plate waste to code at a later date.<sup>5</sup> The feasibility of DI was established using a team comprising of 15-20 undergraduate and graduate research assistants trained as part of a semester-long class.<sup>5</sup> Other studies using DI dietary assessment in the elementary school cafeteria environment also used researchers or clinicians to collect the data.<sup>6</sup>

A limitation of using a trained university research team is the feasibility of collecting data remotely in large samples in geographically diverse settings. Previous studies using this methodology were conducted within 1-2 hours of the university.<sup>5</sup> One alternative to using a trained university research team is to engage school-based volunteers (i.e. parents or teachers) in data collection. Non-research professionals have

been trained to enter data and demonstrated high inter-rater reliability in comparison to researchers in the school food environment using a computerized competitive food assessment tool.<sup>7</sup> When assessing dietary intake, adult volunteers were trained and successfully captured digital images of meals.<sup>8</sup> The primary objective of this study was to compare the feasibility of DI data collection by a university-based trained dietary assessment team (UDAT) to a parent volunteer dietary assessment team (PDAT) and a teacher dietary assessment team (TDAT) during lunch at two Northeast elementary schools (NES). The secondary objective was to assess the PDAT and TDAT perceived facilitators and barriers to the DI data collection process.

## **METHODS**

### **School and School-based Team Recruitment**

School nutrition directors and school principals from two Northeast school districts were contacted during September-October 2013 and two elementary schools serving grades 3-5 (NES-A and NES-B) within those districts were recruited for the study. Schools were awarded a \$300 incentive and allowed to keep the digital cameras used for data collection upon completion of the study. The University Institutional Review Board designated the protocol as exempt since no identifying information on school children was collected. Following recruitment, a member of the UDAT visited the school to perform a cafeteria environment assessment to determine factors that could affect the feasibility of collecting DI pairs such as the number of lunch lines, whether students were assigned seating during lunch, number of disposal areas, etc. (Table 1).



At each school, a dedicated and enthusiastic parent volunteer (NES-A) or teacher volunteer (NES-B) was identified to serve as the “School Nutrition Champion” (SNC) to organize a school-based team and serve as a liaison between the university researchers and their team. The SNCs formed a PDAT and TDAT team at NES-A and NES-B, respectively. At NES-A the SNC recruited four other parent volunteers to participate in the study. At NES-B the SNC recruited two teacher volunteers and the school principal (Table 1).

### **DI Training Workshop and Modeling Day**

The UDAT DI training and data collection was previously coordinated by a nutrition graduate student with a team of 10-20 nutrition majors as part of an undergraduate dietary assessment research class.<sup>5</sup> The UDAT training protocol was adapted to a 3-hour DI training workshop better suited for parent and teacher schedules.

During December 2013 and January 2014, the school-based teams participated in the DI training workshop. A pre-training survey was administered to the team to assess current involvement in the school meal environment (i.e. if team members monitor school lunch) and skills pertaining to involvement in data collection (i.e. familiarity with using a digital camera). Content of the DI training workshop included: background on digital imaging as a dietary assessment methodology, functionalities of the digital camera, collecting fruit and vegetable menu items and recipes, lanyard distribution, and capturing a pre- and post- DI.

After the training workshop, a DI modeling day was performed by the UDAT for the school-based teams to demonstrate the DI data collection process in each unique cafeteria environment.

### **Data Collection**

Twenty data collection visits (ten NES-A, ten NES-B) during Spring 2014 were scheduled with participating schools. At each school, five UDAT data collection days were staggered with five PDAT (NES-A) and five TDAT (NES-B) data collection days. On days when the PDAT or TDAT collected data, a member of the UDAT was present during the lunch period to unobtrusively monitor and record adherence to the study protocol.

Three team members arrived at the cafeteria approximately five minutes before the start of lunch. Students in grades 3-5 participating in the National School Lunch Program (NSLP) were eligible to participate in data collection. One team member was responsible for distributing uniquely labeled lanyards to every eligible student as they lined up for a lunch tray (Fig. 1). This team member counted and recorded the number of lanyards distributed.

After the students received the lanyards, they went through the lunch line to select meal items. Upon exiting the lunch line, one of the two team members assigned to DI captured a pre-image of students' trays (Fig. 1) using a Canon PowerShot ELPH 320 HS digital camera (Canon, Melville, NY) held at approximately 75° and 18-24 inches above the lunch tray. As the students approached the disposal area, one of two DI team

members captured a post-image of the tray (Fig. 1). The team member responsible for lanyard distribution collected the lanyards from students after they disposed of their plate waste or before they exited the cafeteria.

On the last day of data collection at both schools, all team members were administered a post-data collection survey to assess areas including changes in attitudes and knowledge towards school nutrition and meals, involvement in data collection (e.g. knowledge of camera functionalities, lanyard distribution), DI training experience, and development of future DI trainings.

### **DI Data Transfer and Sorting**

Following a PDAT or TDAT data collection day, one designated team member uploaded the digital images from both cameras to a school or personal computer. The team member transferred the digital image data to the UDAT using Dropbox© (Dropbox, Inc., San Francisco, CA). Upon receipt, a UDAT member sorted and labeled the digital images based on the lanyard numbers. Once the pre- and post- images were sorted, a DI pair or composite image with the pre- and post- image was formed. A usable DI pair was defined as pre- and a post-image in which the lanyard ID number was visible and the DI was taken at the correct zoom/angle allowing the DI pairs to be coded by the UDAT for fruit and vegetable (FV) selection, consumption, and plate waste (Fig. 1).

### **Focus Group**

After data collection was completed, both school-based teams were invited to the university campus during July 2014 to participate in a focus group. The team members

were offered a \$25 gift card incentive to a local garden supply store. Two team members from the TDAT and four members from the PDAT participated in the focus group.

Focus group questions were developed based on preliminary analysis of the post-survey administered to the school-based teams after data collection was completed as well as input from UDAT members. The main areas addressed included: the cafeteria environment and data collection, student behavior and data collection, the burden of collecting data, engaging other schools in data collection, and attitudes towards the importance of dietary assessment research. A set of “problem solving” questions encompassed areas such as transferring DI data and the sustainability of collecting DI data at each school. Questions were semi-structured and facilitated by a moderator who was a member of the UDAT. The focus group was audiotaped, transcribed, and verified by a separate member of the UDAT. Two UDAT members independently reviewed and coded the focus group transcript. Predominant themes were identified using inductive and deductive thematic analysis.<sup>9</sup>

### **Statistical Analyses**

DI data collection feasibility was defined as percentage of eligible pairs collected, which was calculated as total number of DI pairs collected out of the total number of eligible DI pairs (based on the number of lanyards distributed) across all data collection days for each of the three teams (PDAT, TDAT, UDAT at NES-A, UDAT at NES-B). Two binary logistic regressions were conducted using IBM SPSS Statistics for Windows version 22.0 (Armonk, NY: IBM Corp): 1) comparing the feasibility of collecting DI data between the PDAT and UDAT at NES-A and 2) comparing the feasibility of collecting

DI data between the TDAT and UDAT at NES-B. The independent variable for each analysis was team assignment. The dependent variable was the capture of a usable DI pair based on the total number of lanyards distributed across all data collection trips. This was a dichotomous variable that was coded “1” and “0” based on whether a usable DI pair could or could not be formed, respectively. Statistical significance level was set at  $P < .05$ .

## **RESULTS**

### **Feasibility Results**

At NES-A, across five data collection trips the UDAT distributed a total of 320 lanyards. Of the lanyards distributed, 81.9% ( $n=262$ ) were usable DI pairs. The PDAT distributed a total of 294 lanyards across five data collection trips and 74.1% ( $n=218$ ) were usable DI pairs (Table 2). At NES-A the UDAT was more proficient at collecting usable DI pairs than the PDAT ( $B=-0.45$ , 95% CI=-0.84 - 0.07,  $P < .05$ ).

At NES-B, the UDAT distributed 401 lanyards over five data collection trips and 91.3% ( $n=366$ ) were usable DI pairs. The TDAT distributed 350 lanyards across five trips. However, a team member mistakenly mass deleted the DIs from one trip prior to transferring the data to the UDAT. Since this would affect (underestimate) the true feasibility of DI data collection by the TDAT, only four trips were used decreasing the total number of lanyards distributed to 268. Of the lanyards distributed, 95.8% ( $n=257$ ) were usable DI pairs (Table 2). At NES-B, the TDAT was better able to capture usable DI pairs than the UDAT ( $B=0.80$ , 95% CI=0.11-1.15,  $P < .05$ ).

## **Focus Group**

The themes that emerged through the focus group with both the PDAT and TDAT included: the importance of volunteer investment in the study, the impact of “non-researcher” rapport with children, the impact of the cafeteria environment on data collection, the desire to connect data collection with nutrition education opportunities, challenges with data transfer, and the importance of incentives to promote the sustainability of data collection (Table 3).

Both teams conveyed an investment in the study purpose and methodology by expressing the importance of knowing what children were eating in the cafeteria. One of the PDAT members exclaimed how she had to “bite her tongue” in reacting to how few FVs were included on the students’ trays (or selected by students). Investment in the study was also evident by the strategies team members adopted to facilitate data collection, including ways to not miss trays as students exited the lunch line for pre-imaging. The rapport that the PDAT and TDAT as “non-researcher” volunteers had with the students was perceived to facilitate, not take away, from the data collection process.

The importance of the cafeteria environment was a strong focus of the conversations between the two different teams. Both teams explained that pre-imaging was easier than post-imaging due to the organization and steady flow of the cafeteria lunch line. Lunch disposal affected post-imaging since it was not as organized as one class going through the lunch line at a time. Teams were challenged to collect post-images because students were permitted to eat lunch outside of the cafeteria in the band room and the guidance counselor’s office at one school and by attending a reading circle

at the other. Both teams agreed that training volunteer team members should be tailored to the unique cafeteria environment and incorporate a focus on student traffic patterns.

The investment of the parent and teacher volunteers in the data collection process translated into a desire to connect data collection with nutrition education opportunities for the students. Examples of educational opportunities mentioned included sharing with the students the types and amounts FVs they selected from the lunch line and comparing this to what was actually consumed as well as teaching about the importance of sustainability through the food waste data. One PDAT volunteer shared:

There's a tangent between running this study and attaining the data with this overall bigger picture. You know everyone who participated is kind of on board towards improving school nutrition for sure but then how do we get that back, like at what point do we actually divulge what we are looking at and make on-the-ground changes for kids at our schools?

Data transfer was acknowledged as a barrier to both teams' involvement in the data collection process including lack of access to computers, technical challenges with uploading and transferring the DIs via DropBox, and time issues following the scheduled school lunch. T DAT members explained that once they left the cafeteria their focus shifted immediately back to their responsibilities in the classroom:

As a teacher, I would step back in the classroom and just like that the camera was out of mind because there were much more pressing, immediate issues.

Both teams shared the opinion that a separate volunteer role for DI upload and transfer would alleviate one burden of data collection:

If I could have handed that camera to someone and they could have dealt with the uploading, it would have been a lot less anxiety-producing.

The last main theme that emerged during the focus group was the importance of the incentives provided to the team for their participation in the study. Both teams spoke to the benefit of the monetary incentive and explained that this may be important to engage other schools and motivate team members:

Well, you just keep reminding yourself, this is going to be really helpful for our school trip, you know.

## **DISCUSSION**

In a school cafeteria setting, teacher volunteers may be more suitable for collecting DI dietary assessment data than parent volunteers and university researchers.

The findings of this study point to a promising extension of DI dietary assessment methodology for use in large, geographically diverse samples located remotely from university settings. Involving school-based volunteers in data collection efforts can save time and resources on the part of the research team, and be rewarding for the individual school involved. The focus group findings from this study suggested facilitators and barriers to the data collection process for school volunteers.

School-based teams were invested in this research above and beyond data collection responsibilities during school meals. The TDAT's success collecting usable DI was likely bolstered by the unique rapport the teachers have with their students. The quality of relationships that teachers report having with children can affect both behavior



and achievement.<sup>10</sup> In the current study, the dynamic between teachers and students in the classroom may have improved the elementary school students' adherence to the data collection procedures.

The school-based teams expressed an investment in the applications of dietary assessment through their interest in what FV children were consuming during school meals and desire to translate FV consumption and waste data into nutrition education for the children. School cafeteria meals are a promising setting for promoting knowledge and skills surrounding foods and school meals can be developed as a learning tool to connect teachers and students.<sup>11</sup> When addressing the school cafeteria food environment teacher<sup>12</sup>, community, and family involvement<sup>13</sup> are integral to the adoption of both healthy nutrition and physical activity practices in schools.<sup>12, 13</sup>

One previous DI data collection approach that has not been validated in the elementary school cafeteria setting involves setting up a digital video camera with a fixed distance and angle and having the students place their tray on a mat to be photographed.<sup>14,</sup><sup>15</sup> However, the feasibility of this method may be limited in a larger, fast-paced school cafeteria environment where there are multiple food stations and students quickly moving through the lines. The quality and validity of these data may be compromised if there are obstructions blocking the FV items and if seconds are taken after the pre-image is captured. Previous work by our research team supports having trained research personnel on-site to ensure that quality DI data is collected and data collection does not affect the cafeteria environment, including lunch line traffic.<sup>5</sup>

## **Limitations**

There are limitations to our study. Teacher and parent availability and willingness to participate in data collection during elementary school lunches may not be generalizable to all schools. For example, teachers in other schools might be overburdened and unable to commit a lunch period to data collection. Also, collecting DI data for a study on consecutive days may not be feasible with a small team of 4-5 members. In the current study, school-based team members referenced the importance of the monetary incentives to their involvement in the study. If data were collected for a longer period of time (entire school year), the incentives may need to increase.

In this feasibility study, usable DI pairs were not further analyzed to quantify actual FV selection and consumption. Data collected by school-based teams may evoke a social desirability bias in FV selection and consumption by the students. However, the team members were not new to the cafeteria environment. Students were accustomed to teachers and parents being in the cafeteria setting for lunchroom monitoring. Results may have been affected by data lost through accidental deletion of one day's data for one team, although there was no indication that these data differed from that collected on other days by the team.

## **IMPLICATIONS FOR RESEARCH AND PRACTICE**

As of the 2012 school year, the United States Department of Agriculture requires school children to select either a fruit or a vegetable with a reimbursable meal.<sup>16</sup> However, there were a limited number of studies using rigorous, validated dietary assessment methods to measure school children's FV selection, consumption, and

waste.<sup>17, 18</sup> Schools may be able to engage teachers to collect DI data to assist in the evaluation of policy changes or other strategies such as Farm-to-School programs, school gardens, and behavioral interventions aimed at increasing children's FV consumption. Another benefit of having on-site school-based volunteers collect DI data is improved feasibility of collecting follow-up data to evaluate the impact of interventions and/or policy changes.

In the present study, the university-based dietary assessment team trained school-based teams. To support remote data collection efforts in an increased number of geographically diverse schools, a Web-based tool could be a feasible training strategy. Web-based trainings have been used with volunteers for a variety of disciplines and have been shown to be effective and efficient.<sup>19-23</sup> Researchers have demonstrated that this mode of training can reach larger audiences in rural and far-reaching geographic settings with significant cost savings.<sup>19, 20</sup>

This feasibility study assessing school-based volunteers' ability to collect DI dietary assessment data highlighted the additional benefit that this research approach can have on school nutrition efforts. Given the importance of increasing school-based initiatives to promote nutritious food choices by students,<sup>24</sup> parent and teacher involvement in research may provide unique opportunities for both addressing and measuring dietary behaviors during school lunch.

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## TABLES

<b>Table 1.</b> Demographic, Cafeteria Environment, and School-based Team Characteristics of Two Northeast Elementary Schools.		
<b>Demographic Characteristics of Participating Schools</b>	NES-A <sup>a</sup>	NES-B <sup>b</sup>
Grade 3-5 enrollment (n)	146	405
Eligible for sample (n) <sup>c</sup>	146	125 <sup>d</sup>
Student eligibility for free or reduced price lunch (%)	9	22
Ethnicity (%)		
White	95	93
Non-white <sup>e</sup>	5	7
<b>Cafeteria Environment of Participating Schools</b>		
Entrée stations	Featured Entrée	Featured Entrée
Salad bar	Yes	No
FV serving style	Pre-portioned Entrée, Self-serve salad bar, Self-serve Juice	Pre-portioned Entrée, Pre-portioned FVs
Number of Lunch Lines	2	1
Different Grades Mixed with Study Sample During Lunch Period	Yes	No
Students are Assigned Seats During Lunch	No	No
Students from Sample Given Opportunity to Eat and Dispose of Trays Outside of Cafeteria Environment	Yes <sup>f</sup>	Yes <sup>f</sup>
Number of Disposal Areas	1	1
Composting Station	Yes	Yes

Students Dismissed to Dispose Trays by Table	No	Yes
<b>School-based Team Composition</b>		
Involvement of School Nutrition Director	Yes	Yes
Teacher/School Principal-based Team (n)	N/A	4
Parent-based Team (n)	5	N/A

<sup>a</sup> NES-A = Northeast Elementary School-A

<sup>b</sup> NES-B = Northeast Elementary School-B

<sup>c</sup> Eligible for sample = student eligibility for sample is based on whether they attended the lunch during which data were collected

<sup>d</sup> Sample included students in grades 4 and 5

<sup>e</sup> Non-white = Black, Hispanic, Asian, Other

<sup>f</sup> Students were permitted to eat lunch in school band room, guidance counselor's office, or reading circle

<b>Table 2. Feasibility of Collecting Digital Image (DI) Pairs in Two Northeast Elementary School Cafeterias (Grades 3-5)</b>						
	NES-A <sup>a</sup>		<i>P</i>	NES-B <sup>b</sup>		<i>P</i>
	UDAT <sup>c</sup>	PDAT <sup>d</sup>		UDAT	TDAT <sup>e</sup>	
Number of lanyards distributed to students (n)	320	294		401	268 (350 <sup>f</sup> )	
Percent DI pairs (%)	81.9 (n=262)	74.1 (n=218)	0.02	91.3 (n=366)	95.8 (n=257)	0.02

<sup>a</sup> NES-A = Northeast Elementary School-A

<sup>b</sup> NES-B = Northeast Elementary School-B

<sup>c</sup> UDAT = University Dietary Assessment Team

<sup>d</sup> PDAT = Parent Dietary Assessment Team

<sup>e</sup> TDAT = Teacher Dietary Assessment Team

<sup>f</sup> 350 lanyards were distributed, but DI data from 82 students were not eligible for DI sorting as the images were deleted from one camera prior to data transfer.



<b>Table 3.</b> Parent-based Dietary Assessment Team and School-based Dietary Assessment Team Focus Group Themes
The importance of volunteer investment in the study.
The impact of “non-researcher” rapport with children.
The impact of the cafeteria environment on data collection.
School-based dietary assessment teams’ desire to connect data collection with nutrition education opportunities
Challenges with data transfer.
The importance of incentives to promote the sustainability of data collection.

## FIGURE

**Figure 1.** Pre- and post- digital images of lunch tray and visible student lanyard during elementary school lunch data collection.



**Chapter 5: Nudging pre-school children's fruit and vegetable consumption during afternoon snack time using older child mentors from the Live Y'ers afterschool program**

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**Key words:** pre-school, fruit and vegetables, mentors

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## ABSTRACT

**Background:** Dietary behaviors in children are developed during the first five years. Pre-schools represent an important environment for addressing children's fruit and vegetable (FV) consumption since an increased number of children are consuming meals outside of the home.

**Objective:** To evaluate a behavioral intervention addressing pre-school aged children's FV consumption during afternoon snack time using older elementary school children (grades 3-5) as "FV Mentors".

**Design:** Convenience sample with crossover design.

**Participants/Setting:** Pre-school aged children from two Northeast pre-school classrooms (NEPC-A=15, NEPC-B=16) at a YMCA and older children who participated in the Live Y'ers afterschool program.

**Intervention:** FV Mentor modeling FV consumption and using positive verbal cues in addition to teacher verbal cues.

**Main Outcome Measures:** Mean changes in FV consumption across thirty consecutive weekdays for baseline, intervention, and follow-up data collection.

**Statistical Analyses Performed:** ANOVA with mixed design

**Results:** In NEPC-A (n=15), five children (33%) qualified for WIC. There was a significant main effect of time (study period) on FV consumption as measured by the mean amount of cups of FV consumed [ $F(2,10)=7.89$ ,  $P=0.009$ ] across study periods in NEPC-A. At baseline, mean FV consumption was 0.16 cups (95% CI: 0.10-0.22) and increased during intervention ( $M=0.26$  cups, 95% CI: 0.17-0.36) and follow-up ( $M=0.33$  cups, 95% CI=0.28-0.38). The main effect of time was qualified by a significant interaction with type of FV consumed [ $F(8,10)=3.10$ ,  $P=0.049$ ]. In NEPC-B (n=16), there were no children who qualified for WIC and there was not a significant main effect of time on FV consumption [ $F(2,10)=1.10$ ,  $P=0.372$ ].

**Conclusions:** FV Mentors and teacher verbal cues were a beneficial addition to the pre-school snack time interpersonal environment and have the potential to positively influence consumption behaviors of children, especially fruits and particularly in classrooms with children from low SES households.

## INTRODUCTION

The prevalence of childhood obesity in the United States has become one of the most pressing public health issues facing our nation with approximately 12.7 million children between the ages of 2 and 19 obese.<sup>1</sup> Obese children are at a higher risk for type II diabetes<sup>2,3</sup> as well as high blood pressure and high cholesterol.<sup>4</sup> Children's diets are influenced as early as infancy<sup>5</sup> with the first five years marked by the development of important dietary behaviors.<sup>6-9</sup> Fruit and vegetable (FV) consumption has become a central focus of efforts to develop healthy dietary behaviors. FVs confer health benefits including intake of critical shortfall nutrients, reduced risk of chronic diseases, and weight maintenance.<sup>10</sup> However, children are not meeting recommendations for FV consumption.<sup>11</sup> Pre-schools are an important environment for addressing children's FV consumption<sup>12,13</sup> since an increased number of children are consuming meals outside of the home.<sup>14</sup> Approximately 55 percent of children (3-6 years) are in a child care<sup>14</sup> and consume up to one-third of their calories (2-5 years) in this setting.<sup>15</sup>

Pre-school aged children's peers and teachers are primary social influences in pre-school meal and snack environments.<sup>16-19</sup> There is not a definitive consensus regarding the effectiveness of teacher FV modeling on children's FV consumption. Parents may be more effective since children look up to parents as role models, but regard teachers as educators.<sup>16</sup> Peers, especially those of younger children,<sup>20</sup> influence the dietary behaviors of other children in different meal scenarios,<sup>18,21-26</sup> including consumption of new and unfamiliar foods<sup>22</sup> and food amount.<sup>23</sup> Training mentors to

educate and model different dietary and physical activity behaviors in children has been done using both adult<sup>27</sup> and peer mentors.<sup>26</sup> Teachers trained pre-school aged peer mentors to influence food acceptance ten minutes before snack time by instructing the mentor to take a bite of the meal item and exclaim “These X taste good”.<sup>26</sup> This time and resource effective training approach may benefit pre-school children when older children are trained to serve as mentors.

The YMCA has a national presence making it an ideal collaborator for interventions that address youth behaviors, including diet. The YMCA’s mission emphasizes that “lasting personal and social change comes about when we all work together”. Child education and leadership is a priority for the YMCA and others have aligned their research with these values.<sup>28,29</sup> The aim of this study was to evaluate a behavioral intervention addressing pre-school aged children’s FV consumption during afternoon snack time using older elementary school children (grades 3-5) as “FV Mentors” in addition to teacher verbal cues.

## **MATERIALS AND METHODS**

The Director of Pre-school Programs and School Age Site Director at a Northeast YMCA were contacted during fall 2014 to participate in a 30-day pilot study assessing the effect of an interpersonal environment intervention on pre-school children’s (enrolled in age 4 classrooms) FV consumption behaviors during afternoon snack time. Changes to the interpersonal environment included inviting older children (grades 3-5) from the Live Y’ers Afterschool Program to serve as “FV Mentors” by modeling FV consumption and using positive FV verbal cues as well as asking teachers to use positive FV verbal cues as

reinforcement. Two Y Early Childhood Program pre-school classrooms, Northeast Pre-School Classroom A (NEPC-A) and Northeast Pre-School Classroom B (NEPC-B) were recruited for the study.

Following recruitment, a university-based researcher met with the YMCA leadership to review the timeline, parental consent process, day-to-day logistics of data collection, and the snack menu. Consent packages were distributed to parents/guardians of pre-school children and 3<sup>rd</sup>-5<sup>th</sup> grade children. The packages contained an informed consent form, a sociodemographic question regarding participation in the Women, Infants, and Children Supplemental Food Program (WIC), and a food allergy screen. Parents who returned the consent package (regardless of assent/dissent) received a \$10 gift card to a local supermarket. The study duration was 30 consecutive weekdays (Monday-Friday) during the afternoon snack time (3:15PM-3:45PM) with 10 days each dedicated to baseline, intervention, and follow-up data collection. As part of the consent process parents/guardians were instructed not to pack an afternoon snack for their child. All parents/guardians of children in NEPC-A (n=15) and NEPC-B (n=16) consented for their child to participate in the study. Our University-based Dietary Assessment Team (UDAT) comprising of a PhD student, MS student, and 20 undergraduate nutrition students implemented the study.

Pre-school children in the two classrooms were served one of five snacks which included a FV (1/2 cup) with dip (<2 oz.) and a grain snack (1/4 cup). The 5-day snack menu included: 1) red grapes with Greek yogurt dip and multi-grain Cheerios, 2) baby carrots with hummus and multi-grain pita chips, 3) clementine with Greek yogurt dip and

multi-grain animal crackers, 4) peapods with ranch dip and Wheat Thins, and 5) pepper spears with salsa and multi-grain tortilla chips. Children were permitted to take seconds of any FV snacks, but not the whole grain snack or dip. All snacks were prepared in a clean and sanitary environment (University Foods Lab) by the research team the morning of data collection. FV snack items were properly washed, weighed (to nearest gram), individually packaged, and stored in the Foods Lab refrigerators before transporting them to the YMCA for data collection.

During the 30-day study period, pre-school children in each classroom were assigned to “clusters” of 3-4 children. One member from the research team was assigned to each cluster to serve the snack, record the FV snack ID (corresponding to pre-recorded weight), and unobtrusively observe and record consumption behaviors (FV refusals, facial expressions, etc.) and all verbal cues by teachers and FV Mentors. As each child finished his/her snack or when the snack time ended around 3:45PM, the children disposed their FV waste in a separate FV disposal bin reserved for that particular cluster. During the intervention period, the FV Mentors had a separate bin for their FV waste at each cluster. The waste bag containing the FV waste was weighed on a Cuisinart Digital Kitchen scale after snack time was finished to determine total FV waste and ultimately FV consumption (FV selection – FV waste).

During the ten days of baseline data collection and the ten days of follow-up data collection periods, pre-school teachers and assistant teachers were instructed to not use positive FV verbal cues that normally would not be used during snack time. The research team briefly met with FV Mentors during baseline to review their role of modeling FV



consumption and using positive verbal cues to encourage FV consumption during the intervention period. Due to the limited availability of FV Mentors, the classrooms had five days of teacher verbal cues and five days of teacher verbal cues combined with FV Mentors (ten days total). Teachers and assistant teachers were provided with two prescribed FV-specific classroom verbal cues that were to be used at the beginning and middle of the snack time. They were instructed to use additional positive FV verbal cues to clusters and individual children as appropriate.

To organize FV Mentors during the intervention period, 10 minutes before snack time a member of the research team went to the afterschool classrooms and identified 4-5 volunteers for data collection that day, usually by asking “Who likes the fruit or vegetable ‘X’?”. The research team member briefly reviewed the role with the FV Mentor by asking the older child to try to finish their FV snack (and seconds if they wanted) and to use positive verbal cues with the pre-school children to encourage them to try and take more bites of their FV snack. The research team provided examples of tailored cues to use such as “This carrot is really crunchy” or “Let’s see how juicy these clementines are”, but also encouraged the FV Mentors to come up with fun cues on their own. FV Mentors also had the opportunity to play a game or puzzle with their assigned pre-school children at the end of snack.

Mean FV consumption was calculated following snack time for each pre-school classroom and FV Mentors during the 30 days of data collection. The independent variable was time period (baseline, intervention, follow-up) and a between subject variable of FV type with five levels (grape, carrot, clementine, pea pod, and pepper

spears). The dependent variable was mean FV consumption for each classroom measured in cups. To investigate the effect of study period and FV type on mean FV consumption, we conducted repeated measures ANOVA with a mixed design. Statistical Power calculations for the original study design were based on 10 data collection days per study period (baseline, intervention, and follow-up) in two classrooms. Assuming a medium effect size (0.5 standard deviation unit) or strength of association, this design had a power of .84 to detect between group, within group and between-within interaction effects. All analyses were performed using SPSS (version 21.0;SPSS Inc.). The University Institutional Review Board approved of this study.

## **RESULTS**

The research team was informed that the YMCA randomly assigned children to classrooms; however, it appeared that classroom assignment was non-systematic. There were significant differences in socioeconomic status (SES) and baseline FV consumption between the classrooms. Consequently, the classrooms were analyzed separately, with each classroom compared to its own baseline.

### **FV Consumption in NEPC-A and NEPC-B**

In NEPC-A (n=15) five children (33.3%) qualified for WIC (as reported by their parent). WIC is commonly used as an indicator of lower SES. Based on the repeated measures ANOVA with mixed design analysis, there was a significant main effect of time on FV consumption as measured by the mean amount of cups of FV consumed [ $F(2,10)=7.89, P=0.009$ ] across study periods. Mean consumption was lowest at baseline

at 0.16 cups (95% CI: 0.10-0.22) and increased during the intervention period ( $M=0.26$  cups, 95% CI: 0.17-0.36) and the follow-up period ( $M=0.33$  cups, 95% CI=0.28-0.38, Table 1, Fig.1).

The main effect of time (study period) was qualified by a significant interaction between time and type of FV consumed [ $F(8,10)=3.10$ ,  $P=0.049$ ] indicating that the effect of study period on FV consumption depended on the type of FV consumed. The largest change in consumption across study periods was in fruits including grapes, which increased from 0.43 cups during baseline ( $SD=0.11$ ) to 0.96 cups ( $SD=0.01$ ) during the follow-up period. Clementines also exhibited a substantial change from 0.15 cups ( $SD=0.01$ ) at baseline to 0.37 cups ( $SD=0.05$ ) during the follow-up period. Peppers were the only vegetable in NEPC-A that increased by more than 0.05 cups, with a mean of 0.20 cups ( $SD=0.03$ ) consumed during the intervention period compared to 0.11 cups ( $SD=0.03$ ) at baseline (Fig. 1).

For overall FV consumption in NEPC-A, collapsing across the study periods, grape consumption was the highest at 0.67 cups (95% CI: 0.58-0.76). Pairwise comparisons demonstrated that grape consumption was significantly greater than all other FV ( $P<0.01$ ). The next highest consumed FV were clementines ( $M=0.27$  cups, 95% CI: 0.18-0.36), followed by peppers ( $M=0.15$  cups, 95% CI: 0.06-0.24), carrots ( $M=0.11$  cups, 95% CI: 0.02-0.2), and peapods ( $M=0.06$ , 95% CI: -0.03-0.15), though none of the other pairwise comparisons were significant in NEPC-A.

In NEPC-B ( $n=16$ ), there were no children who qualified for WIC (as reported by their parent). In contrast to NEPC-A, there was not a significant main effect of time on

FV consumption [ $F(2,10)=1.10$ ,  $P=0.372$ ] indicating that there were no significant differences from baseline to intervention to follow-up. Mean consumption in NEPC-B at baseline was more than twice the amount of NEPC-A ( $P<0.05$ ) at 0.34 cups (95% CI=0.10-0.22) totaling approximately 70% of the  $\frac{1}{2}$  cup FV snack serving (Table 1, Fig.1). Mean FV consumption was highest during the intervention period ( $M=0.41$ , 95% CI: 0.30-0.52) and decreased slightly during the follow-up period ( $M=0.38$ , 95% CI: 0.31-0.44) although these changes were not significantly different ( $P=0.372$ ). See Table 2 and Fig. 1.

### **FV Mentor Consumption and Mentor/Teacher Verbal Cues in NEPC-A and NEPC-B**

During the five days when FV Mentors were in the NEPC-A, there were 4-6 FV Mentors who volunteered to participate during snack time on each of the days. The range of FV verbal cues spoken by FV Mentors for NEPC-A recorded was between 10 and 21 with an average of 15 verbal cues per day in this classroom. Examples of FV Mentor cues are shown in Table 2. Mean FV consumption for the mentors in NEPC-A was 0.61 (95% CI: 0.39-0.82) or 1.22 servings (Table 1). All of the FVs except for peapods ( $M=0.39$ ) exceeded the  $\frac{1}{2}$  cup serving size with clementines being consumed the most ( $M=0.83$ ). Teacher FV verbal cues in this classroom averaged five cues per day.

In NEPC-B, between 4-6 FV Mentors were willing to eat afternoon snack with the pre-school children during the five intervention (FV Mentor + Teacher Verbal cue) days. FV Mentor verbal cues in NEPC-B ranged from 4-10 with an average of 8 verbal cues per day (Table 2). Mentors in this classroom consumed a mean of 0.68 cups (95% CI:

0.30-1.06) or 1.36 servings of FV (Table 1). Similar to NEPC-A, peapods ( $M=0.39$ ) were consumed less than the standard  $\frac{1}{2}$  cup serving size as well as carrots ( $M=0.42$ ). The mean number of teacher verbal cues in NEPC-B was higher than NEPC-A at 9 cues per day.

## DISCUSSION

This pilot study suggested that changes to the interpersonal environment during snack time may benefit pre-school aged children's FV consumption. The impact of FV Mentors modeling FV consumption and using positive verbal cues combined with teacher verbal cues was observed in NEPC-A, the classroom with more children coming from low SES households due to one-third of them being eligible for WIC. FV consumption in NEPC-A more than doubled from the baseline period to the follow-up period increasing by 0.17 cups. This increase suggested that the effect of the FV Mentors plus teacher verbal cues on FV consumption was sustained after the intervention ended. FV consumption in NEPC-B did not significantly change throughout the study.

The effect of the FV Mentors plus teacher verbal cues on FV consumption in NEPC-A was influenced by the type of FV snack with fruits, especially grapes, consumed significantly more than all other FV snacks offered. Grape consumption in NES-A accounted for much of the mean increase in FV consumption from baseline through the follow-up period. The challenges of promoting vegetable consumption are not unique to this intervention<sup>19,30</sup> and even repeated exposure<sup>19,30</sup> of vegetables in the pre-school setting may not increase willingness to try<sup>30</sup> or consume vegetables.<sup>19</sup> Another factor that may have affected vegetable consumption is the seasonality and quality of FV

used for snacks. The research team made an effort to shop for the highest quality FV throughout data collection. However, peapods were not in season at the time of data collection (March and April) and the research team's taste testing of this snack before it was served indicated changes in flavor across different data collection days. Variance in the quality of FVs across time periods, may affect consumption. In future studies, it may be beneficial to incorporate FVs that are in season for snacks.

The differences in consumption between the two pre-school classrooms was significant with NEPC-B consuming more than twice as much during the baseline period as NEPC-A. The reason for the difference in FV consumption may, in part, be attributed to the SES differences between the two classrooms. The affordability of FVs may affect children's exposure to FVs in NEPC-A and NEPC-B. A recent study highlights socioeconomic differences with regards to fruit consumption in both adults and children with total fruit and whole fruit consumption higher among those with higher income and 100% fruit juice higher in lower income groups.<sup>31</sup>

To promote FV consumption in low-income populations, a 2009 nationwide policy revision added a cash-value FV voucher (CVV) to the WIC food package allocating \$10 to women and \$6 to each child per month.<sup>32</sup> This revision may encourage WIC vendors to reduce FV prices for WIC recipients to further improve their purchasing power.<sup>33</sup> A description of FV purchases by women using the WIC CVV found an increase in the volume of FVs purchased including: a 17.5% increase in fresh vegetables, 27.8% increase fresh vegetables, and 28.6% increase in fresh fruit.<sup>34</sup> Overall, families taking

advantage of the CVV may help improve low-income children's exposure to FVs in the home environment.

The role of the home environment must also be considered when addressing FV consumption in pre-school aged children. The home environment has been recognized for its role in shaping the dietary behaviors of children through family mealtimes<sup>35</sup> and parental influence.<sup>16,35-42</sup> The beneficial effects of parental modeling and exposure to FVs on children's FV consumption has been well documented,<sup>16,35-42</sup> whereas pressuring a child to eat their food can have a negative impact.<sup>43</sup>

Other strategies combined with FV Mentors may promote consumption of a variety of FVs, including vegetables. In the current study we served all fruits and vegetables with a dip since serving them this way may improve consumption.<sup>44</sup> Other approaches to improve FV consumption include providing a variety of familiar FV,<sup>45</sup> and serving fruits<sup>46</sup> and sometimes vegetables before the entrée is served.<sup>46,47</sup> FV-focused education and activities have had mixed success with this age group<sup>16,48-53</sup> and vary in complexity from comprehensive and interactive curriculums,<sup>16,50-52</sup> to using picture or storybooks,<sup>48</sup> bilingual board games,<sup>53</sup> and involvement in meal preparation.<sup>49</sup>

## **CONCLUSIONS**

This pilot study addressing the pre-school snack time interpersonal environment in a local YMCA demonstrated promise as an easy to implement and cost-effective approach to encourage positive FV consumption behaviors, especially fruit and particularly in classrooms with children from lower SES households. Our findings suggest that other strategies may need to be considered to increase vegetable

consumption; however, FV Mentors did not have a negative impact on vegetable consumption in this study.

Training children from the Live Y'ers afterschool program to model positive FV consumption behaviors and to use verbal cues reinforces core values of the YMCA including leadership and community involvement. The YMCA prioritizes the health and wellness of children through national initiatives including Healthy Kids Day<sup>®</sup> that over 1,500 Y's across the country participate in.<sup>54</sup> Given the success of our collaboration with a Northeast YMCA, future research can access this vast network of YMCAs to assess the feasibility and effectiveness of FV Mentors in YMCAs with varied geographic and socioedemographic characteristics.



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## TABLES

<b>Table 1.</b> Mean Fruit and Vegetable (FV) Snack Consumption of Two Northeast Pre-school Classrooms (Age 4) and FV Mentors (Grades 3-5) during Baseline, Intervention, and Follow-up Periods								
	NEPC-A <sup>a</sup> (n=15)			<i>P</i>	NEPC-B <sup>b</sup> (n=16)			<i>P</i>
	Baseline cups (95% CI)	Intervention cups (95% CI)	Follow-up cups (95% CI)		Baseline cups (95% CI)	Intervention cups (95% CI)	Follow-up cups (95% CI)	
Mean Amount of FV Consumed by Pre-School Children (cups)	0.16 <sup>c</sup> (0.10, 0.22)	0.27 (0.17, 0.37)	0.33 <sup>c</sup> (0.28, 0.38)	0.009**	0.34 (0.25, 0.44)	0.41 (0.30, 0.52)	0.38 (0.31, 0.44)	0.372
Mean Amount of FV Consumed by FV Mentors (cups)		0.61 (0.39, 0.82)				0.68 (0.30, 1.06)		

<sup>a</sup> NEPC-A = Northeast Pre-School Classroom A

<sup>b</sup> NEPC-B= Northeast Pre-school Classroom B

<sup>c</sup>Denotes that pair-wise comparisons were significantly different from each other ( $P<0.01$ )

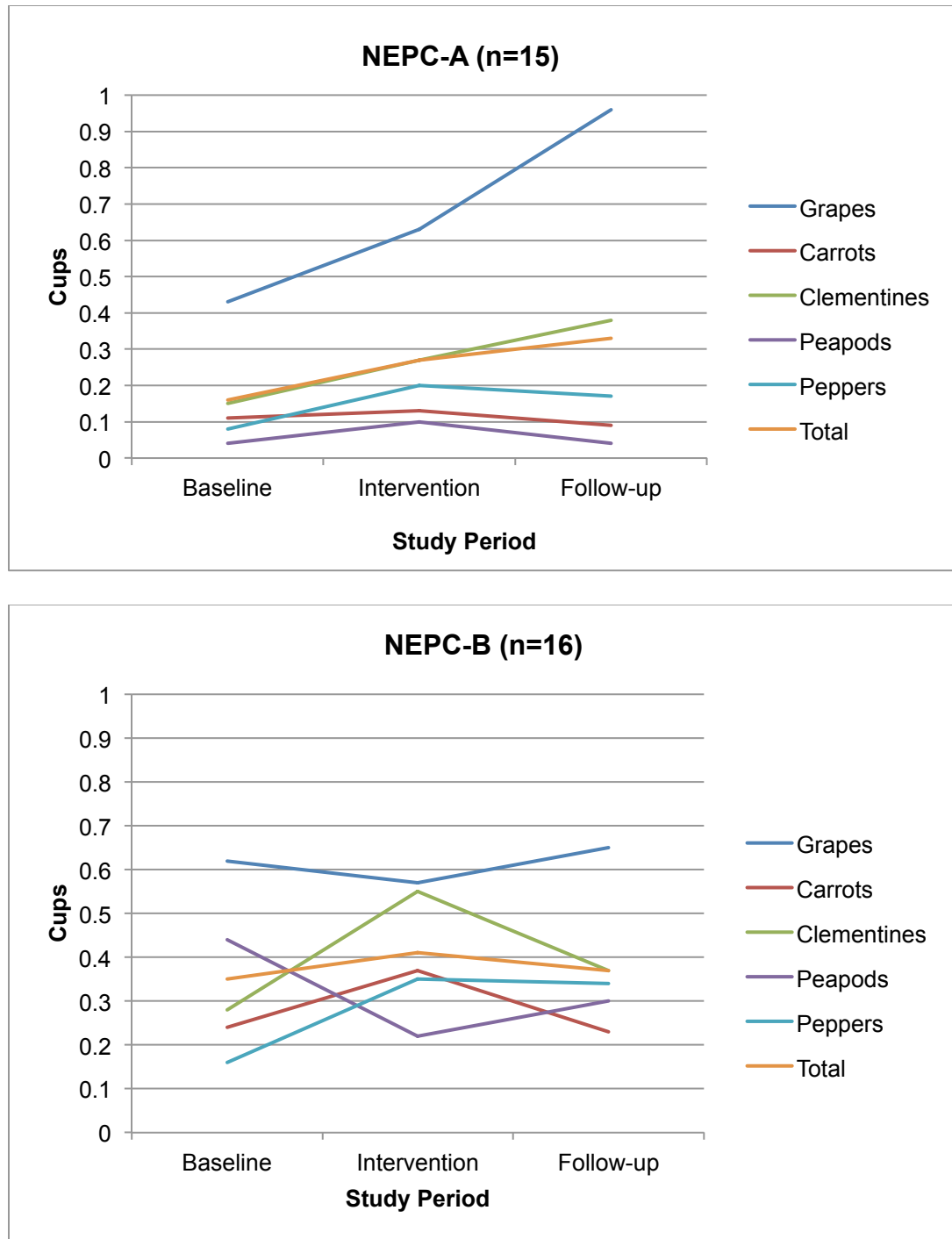
\*Denotes  $P<0.05$

\*\*Denotes  $P<0.01$

<b>Table 2.</b> Examples of Verbal Cues Used by FV Mentors (Grades 3-5) in Two Northeast Pre-School Classrooms (Age 4) During Intervention Period		
<b>FV Type</b>	<b>NEPC-A FV Mentor Verbal Cues</b>	<b>NEPC-B FV Mentor Verbal Cues</b>
Peapods	<p>“Mmm, they’re really sweet! See the peas inside”</p> <p>“You should at least try them. They’re crunchy”</p> <p>“Are you enjoying your peas? Let’s try to eat all of them.”</p>	<p>“Big kids eat their peas first, have you tried yours?”</p> <p>“These are all so delish! Are you sure you don’t want to try?”</p>
Peppers	<p>“Want to try them? You should try some of these. Maybe you’ll actually like the peppers”</p> <p>“Peppers make you strong, you know!”</p> <p>“Superman eats these!”</p>	<p>“Try them again, they’re so yummy”</p> <p>“Let’s see who can eat all of their peppers!”</p>
Grapes	<p>“How about you eat your grapes now that you’re done with your Cheerios?”</p> <p>“Weren’t they so good when you started eating them? Come on, keep on doing it!”</p>	<p>“Who’s got the sweetest grapes today?”</p> <p>“What color are the inside of the grapes?”</p> <p>“How many grapes can you make disappear?”</p>
Carrots	<p>“Carrots taste good in hummus!”</p> <p>“The Easter bunny always eats his carrots!”</p> <p>“Carrots are really good for your eyes, you can see like an eagle!”</p>	<p>“Carrots are good for your eyes!”</p> <p>“I see some carrots left. Are you going to eat them?”</p>
Clementines	<p>“Do you think it’s juicy?”</p> <p>“Try a clementine with yogurt, they’re really good”</p>	<p>“Can you tell me how many clementines are in your cup?”</p> <p>“How do they taste? Sweet, juicy?”</p>

## FIGURE

**Figure 1.** Fruit and Vegetable (FV) Snack Consumption of Two Northeast Pre-school Classrooms (Age 4) during Baseline, Intervention with FV Mentors (Grades 3-5), and Follow-up Periods





## **CHAPTER 6: SUMMARY AND CONCLUSIONS**

The purpose of the research described in this dissertation was to address the feasibility of dietary assessment methods and their application to evaluate policy change and behavioral interventions.

As described in chapters 2 and 3, the dietary assessment methodology digital imaging was used to assess the effect of the National School Lunch Program (NSLP) federal regulation changes in 2012. The goal of the USDA rule was to increase children's fruit and vegetable (FV) consumption by requiring school children to select a fruit or a vegetable with a reimbursable meal. In chapter 2, children's selection of different types of fruits and vegetables at two northeast elementary schools (grades 3-5) were described before the NSLP required the selection of a FV with school lunch in spring 2012. Approximately 15% of children did not select a fruit or a vegetable when they were optional. Of the fruits and vegetables children selected, more of them comprised of processed fruits and vegetables including tomato sauce on pizza and 100% fruit juice. Moreover, pre-portioning fruits and vegetables facilitated the selection versus a cafeteria environment where students could self-select (salad bar).

The aim of the study presented in chapter 3 was to assess the amounts of fruits and vegetables elementary school children selected, consumed, and wasted in two northeast elementary schools before the USDA rule in spring 2012 and following the USDA rule in spring 2013. It was concluded that more children selected FV in higher amounts when FV were required. However, this increase in selection did not correspond with children consuming these fruits and vegetables, but rather with increased waste. This application of dietary assessment to evaluate children's FV consumption behavior in both

of these studies revealed that policy change needs to be complemented by concerted efforts in both the school environment and home environment. School-based efforts such as Farm-to-School, school gardens, taste testing, and serving the types of fruits and vegetables students already prefer may improve FV consumption.

The study presented in chapter 4 highlights that in order to rigorously evaluate policy change and interventions at a national level with a larger sample of schools, dietary assessment methods such as digital imaging must be increasingly feasible. Thus, this study aimed to compare digital image data collection by trained university researchers to a parent volunteer dietary assessment team and teacher volunteer dietary assessment team in two northeast elementary schools. Teachers were better able to collect digital image data than both university researchers and parent volunteers. A focus group with these teams corroborated the benefits of having school-based volunteers such as parents or teachers collect the data including: the importance of volunteer investment in the research, the impact of the rapport the parents and teachers have with students, and the desire of these volunteers to connect data collection with nutrition education opportunities at the schools. Overall, training teachers to collect digital image data may foster data collection in far-reaching geographic areas. This approach may also allow for more frequent data collection and more extensive follow-up data collection, which is necessary to evaluate the sustainability of nutrition interventions in the school setting.

Finally, in chapter 5 weighed plate waste dietary assessment methodology was applied to a behavioral intervention in the pre-school setting. The purpose of this pilot study was to evaluate the effect of older children (grades 3-5) as “FV Mentors” from a YMCA afterschool program on pre-school children’s (two age 4 classrooms) FV

consumption during afternoon snack time. The FV Mentors were trained to model FV consumption and use positive FV verbal cues and teachers were instructed to use positive verbal cues during the intervention period. The effect of the FV Mentors and teacher verbal cues was observed in the classroom that had a higher proportion of children participating in Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). FV consumption more than doubled between baseline and follow-up in this classroom (0.17 cups). However, the intervention did not have an effect on the classroom that had no children participating in WIC. This pilot study demonstrates promise as a sustainable initiative that could be adopted by programs like the YMCA that can permit older children to eat meals or snacks with younger children and serve as role models for healthy eating behaviors. Future studies should be conducted in a larger and more diverse sociodemographic sample to assess the effect of older children on meal and snack time behaviors of younger children.

Overall, these studies support the application of dietary assessment methods to evaluate both policy and behavioral interventions and also addresses broader issues in children's food environments. In chapter 2, students' preferences for processed fruits and vegetables and the lower consumption of fruits and vegetables in a low SES classroom in chapter 5 highlights the role that home environment can have in shaping dietary preferences.

Aspects of the home environment, including the decline of family meals and the increase in meals consumed away from home may be contributing to children's food preferences. Policy initiatives in schools and behavioral interventions in pre-schools must be complimented by concerted strategies in the home environment to expose children to

fruits and vegetables and reinforce consumption of these foods. However, these strategies may be out of reach to some families due to the affordability and accessibility of these foods, which may partially explain the lower FV consumption in the lower income pre-school classroom.

This work also highlights the importance of community/institution member and researcher collaboration to implement dietary assessment methods in school-based and community settings (YMCA). In chapters 2 and 3, the research team was limited to collecting FV consumption data at two schools due to labor needs.

Our research team recognized the importance of non-researcher investment in data collection in our research study presented in chapter 4. In the school setting, obtaining a national snapshot of the effect of other policies such as “Smart Snacks in Schools” on FV consumption using validated methods requires efforts above and beyond the research team. Steadfast support and buy-in from teachers and cafeteria personnel, who are already part of the research environment, can be a way to effectively and sustainably collect dietary assessment data to evaluate such policies. The implications of this study may allow us to ramp up dietary assessment to an increased number of geographically diverse schools with enough data collection days to account for variables such as seasonality of fruits and vegetables served and changes in menus and offerings.

The importance of researcher and community collaboration was augmented when implementing a behavioral intervention at the YMCA (chapter 5). In this study, identifying an organization that already values social change, leadership, and education, was integral to the success of implementing our intervention. Training older children who committed to being FV Mentors to younger children points to the value of working with

members of the existing community to implement sustainable interventions and programs.

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